TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1878

VOL. XI.

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE

BY

JAMES HECTOR, C.M.G., M.D., F.R.S.

ISSUED, MAY 1879

WELLINGTON:
LYON & BLAIR, PRINTERS, LAMBTON QUAY.
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PREFACE.

THE Editor acknowledges with thanks the assistance he has received from the following gentlemen in revising the proofs of their papers:—viz., Messrs. Carruthers, J. T. Thomson, Buller, T. Kirk, Buchanan, and T. W. Kirk.

For the Meteorological Statistics, and the illustrations, the thanks of the Board are due to Messrs. Gore and Buchanan respectively, and to Messrs. McColl and Earle of the lithographic department, who, by permission of the Hon. Colonial Secretary, completed the preparation of the plates.

ADDENDA ET CORRIGENDA.

PAGE

32, line 12, *for* Island *read* Land.

32, line 7 from bottom, *for* Peter 1st *read* Peter's.

32, lines 3 and 4 from bottom, *for* Ballemy *read* Balleny.

33, lines 13 and 15, *for* Kemp *read* Kewp.

37, line 5 from bottom, *for* was *read* is.

38, line 1, *for* They *read* Ships.

39, line 18, *for* streets *read* sewers.

51, line 14, *for* consume *read* conserve.

134, line 20, *after* from *insert* the sum of.

136, line 24, *for* the *read* this.

136, lines 5 and 6 from bottom, *after* + *insert* a comma, and at end of each line *add* the minus sign.

137, line 2 from bottom, *omit* To compute the eye and object corrections.

138, before line 1, *insert* To compute the eye and object corrections.

139, line 11 from bottom, *for* verticle *read* vertical.

229, line 13, *for* bases *read* hairs.

229, line 16, *for* leaves *read* hairs.

269, bottom line, *for* duodesma *read* duodenum.

270, line 19, *for* species *read* spines.

354, line 13, *for* Cucubus *read* Cuculus.

354, line 12 from bottom, *for* marginal *read* margined.

366, In title of Art. XLIX., *for* September *read* November.

397, In title of Art. LVI., *for* 30th October *read* 9th November.

469, line 14 from bottom, *for* intro *read* nitro.

474, line 8 from bottom, *for* suitable *read* notable.

536, line 10 from bottom, *for* mataurienis *read* matauriensis.

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NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND, INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

BOARD OF GOVERNORS.

(EX OFFICIO.)

His Excellency the Governor. | The Hon. the Colonial Secretary.

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(ELECTED.)

1878.—James Coutts Crawford, F.G.S., Thomas Kirk, F.L.S., The Bishop of Nelson.

1879.—Thomas Kirk, F.L.S., The Hon. Robert Stout, M.H.R., W. L. Buller, C.M.G., Sc.D., F.L.S.

MANAGER.

James Hector.

HONORARY TREASURER.

The Ven. Archdeacon Stock.

SECRETARY.

R. B. Gore.

ABSTRACTS OF RULES AND STATUTES.

GAZETTED IN THE "NEW ZEALAND GAZETTE," 9 MARCH, 1868.

SECTION I.

Incorporation of Societies.

1. No Society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act 1867," unless such Society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the Society.

2. Any Society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said Society shall at any time become less than twenty-five, or the amount of money annually subscribed by such members shall at any time be less than £50.

3. The bye-laws of every Society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of its annual revenue in or towards the formation or support of some local public Museum or Library; or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and Library of the New Zealand Institute.

4. Any Society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any Society for the time being incorporated with the Institute, shall be deemed to be communications to the Institute, and may then be published as proceedings or transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications :—

Regulations regarding Publications.

(*a*.) The publications of the Institute shall consist of a current abstract of the proceedings of the Societies for the time being incorporated with the Institute, to be intituled, "Proceedings of the New Zealand Institute," and of transactions comprising papers read before the Incorporated Societies (subject, however, to selection as hereinafter mentioned), to be intituled, "Transactions of the New Zealand Institute."

(*b*.) The Institute shall have power to reject any papers read before any of the Incorporated Societies.

(*c*.) Papers so rejected will be returned to the Society before which they were read.

(*d*.) A proportional contribution may be required from each Society towards the cost of publishing the Proceedings and Transactions of the Institute.

(*e*.) Each Incorporated Society will be entitled to receive a *proportional* number of copies of the Proceedings and Transactions of the Institute, to be from time to time fixed by the Board of Governors.

(*f*.) Extra copies will be issued to any of the members of Incorporated Societies at the cost price of publication.

6. All property accumulated by or with funds derived from Incorporated Societies and placed in the charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all Societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the bye-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any Society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the Seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the Society.

SECTION II.

For the Management of the Property of the Institute.

9. All donations by Societies, Public Departments, or private individuals, to the Museum of the Institute, shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to Natural Science may be deposited in the Library of the Institute, subject to the following conditions :—

(*a*.) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b.*) Any funds specially expended on binding and preserving such deposited books, at the request of the depositor, shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c.*) No books deposited in the Library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the Library of the Institute shall be duly entered in a catalogue which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and Library, subject to bye-laws to be framed by the Board.

SECTION III.

14. The Laboratory shall, for the time being, be and remain under the exclusive management of the Manager of the Institute.

SECTION IV.

OF DATE 23RD SEPTEMBER, 1870.

Honorary Members.

Whereas the rules of the Societies incorporated under the New Zealand Institute Act provide for the election of Honorary Members of such Societies; but inasmuch as such Honorary Members would not thereby become members of the New Zealand Institute, and whereas it is expedient to make provision for the election of Honorary Members of the New Zealand Institute, it is hereby declared—

1st. Each Incorporated Society may, in the month of November next, nominate for election as Honorary Members of the New Zealand Institute three persons, and in the month of November in each succeeding year one person, not residing in the colony.

2nd. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as Honorary Members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

3rd. From the persons so nominated, the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be Honorary Members of the New Zealand Institute, provided that the total number of Honorary Members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
Wellington Philosophical Society	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury	22nd October, 1868.
Otago Institute	18th October, 1869.
Nelson Association for the Promotion of Science and Industry	23rd Sept., 1870.
Westland Institute	21st December, 1874.
Hawke Bay Philosophical Institute	31st March, 1875.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1878:—*President*—Thomas Kirk, F.L.S.; *Vice-presidents*—J. Carruthers, M. Inst. C.E., A. K. Newman, M.B., M.R.C.P.; *Council*—James Hector, C.M.G., M.D., F.R.S., J. C. Crawford, F.G.S., W. T. L. Travers, F.L.S., Dr. Buller, C.M.G., F.L.S., C. Rous Marten, F.R.G.S., F.M.S., F. W. A. Skae, M.D., F.R.C.S.E., Martin Chapman; *Auditor*—Arthur Baker; *Secretary and Treasurer*—R. B. Gore.

Office-bearers for 1879:—*President*—A. K. Newman, M.B., M.R.C.P.; *Vice-presidents*—Dr. Hector, Martin Chapman; *Council*—W. L. Buller, C.M.G., Sc.D., etc., C. R. Marten, F. W. Frankland, S. H. Cox, F.C.S., F.G.S., Hon. G. Randall Johnson, W. T. L. Travers, F.G.S., T. Kirk, F.L.S.; *Auditor*—Arthur Baker; *Secretary and Treasurer*—R. B. Gore.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the General Meetings of members of the Society shall be fixed by the Council and duly announced by the Secretary.

AUCKLAND INSTITUTE.

Office-bearers for 1878 :—*President*—T. Heale ; *Council*—R. C. Barstow, Rev. J. Bates, J. L. Campbell, M.D., J. C. Firth, His Honour Mr. Justice Gillies, The Hon. Col. Haultain, G. M. Mitford, J. A. Pond, The Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, M. Inst. C.E., F. Whitaker ; *Auditor*—T. Macffarlane ; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.

Office-bearers for 1879 :—*President*—Rev. A. G. Purchas, M.R.C.S.E. ; *Council*—R. C. Barstow, Rev. J. Bates, J. L. Campbell, M.D., J. C. Firth, His Honour Mr. Justice Gillies, T. Heale, Hon. Col. Haultain, G. M. Mitford, J. Stewart, M. Inst. C.E., T. F. S. Tinne, F. Whitaker ; *Auditor*—T. Macffarlane ; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.

Extracts from the Rules of the Auckland Institute.

1. Any person desiring to become a member of the Institute, shall be proposed in writing by two members, and shall be ballotted for at the next meeting of the Council.

4. New members on election to pay one guinea entrance fee, in addition to the annual subscription of one guinea, the annual subscriptions being payable in advance on the first day of April for the then current year.

5. Members may at any time become life-members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual General Meeting of the Society on the Third Monday of February in each year. Ordinary Business Meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1878 :—*President*—Professor von Haast, F.R.S. ; *Vice-presidents*—Rev. J. W. Stack, Professor Cook ; *Council*—Professor Bickerton, Dr. Powell, W. M. Maskell, R. W. Fereday, Dr. Coward, G. W. Hall ; *Hon. Treasurer*—John Inglis ; *Hon. Secretary*—J. S. Guthrie.

Office-bearers for 1879 : — *President* — Professor Bickerton ; *Vice-presidents*—J. Inglis, R. W. Fereday ; *Council*—Rev. J. W. Stack, Professor Cook, Dr. Powell, Professor von Haast, F.R.S., Dr. Coward, G. W. Hall ; *Hon. Treasurer*—W. M. Maskell ; *Hon. Secretary*—J. S. Guthrie.

Extracts from the Rules of the Philosophical Institute of Canterbury.

21. The Ordinary Meetings of the Institute shall be held on the first Thursday of each month during the months from March to November inclusive.

35. Members of the Institute shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the first of November in every year. Any member whose subscription shall be twelve months in arrear, shall cease to be a member of the Institute, but he may be restored by the Council if it sees fit.

37. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

OTAGO INSTITUTE.

Office-bearers for 1878 :—*President*—W. N. Blair, C.E. ; *Vice-presidents*—Professor Hutton, W. Arthur, C.E. ; *Council*—Professor Shand, G. Joachim, Professor Macgregor, Professor Scott, D. Petrie, E. Elliott, J. C. Thomson ; *Hon. Secretary*—G. M. Thomson; *Hon. Treasurer*—H. Skey; *Auditor*—A. D. Lubecki.

Office-bearers for 1879 :—*President*—Prof. Hutton ; *Vice-presidents*—W. N. Blair, C.E., Prof. Scott ; *Council*—W. Arthur, C.E., Robert Gillies, F.L.S., Dr. Hocken, A. Montgomery, D. Petrie, J. C. Thomson, Prof. Ulrich ; *Hon. Secretary*—Geo M. Thomson ; *Hon. Treasurer*—H. Skey ; *Auditor*—J. S. Webb.

Extracts from the Constitution and Rules of the Otago Institute.

2. Any person desiring to join the Society may be elected by ballot, on being proposed in writing at any meeting of the Council or Society by two members, on payment of the annual subscription of one guinea for the year then current.

5. Members may at any time become life-members by one payment of ten pounds and ten shillings, in lieu of future annual subscriptions.

8. An Annual General Meeting of the members of the Society shall be held in January in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time, until the requisite number of members is present.

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

Office-bearers for 1879 :—*President*—The Right Rev. the Bishop of Nelson ; *Council*—A. S. Atkinson, Leonard Boor, M.R.C.S., Charles Hunter-Brown, F. W. Irvine, M.D., Joseph Shepherd, Geo. Williams, M.D. ; *Hon. Treasurer and Hon. Secretary*—T. Mackay, C.E.

Extracts from the Rules of the Nelson Association for the Promotion of Science and Industry.

2. The Association shall consist of members elected by ballot, who have been proposed at a monthly meeting of the Society, and elected at the ensuing meeting.

3. Each member to pay a subscription of not less than one pound per annum, payable half-yearly in advance.

4. Ordinary Meetings held on the first Wednesday in each month.

WESTLAND INSTITUTE.

Office-bearers for 1878:—*President*—His Honour Judge Weston; *Vice-president*—Robert C. Reid; *Council*—Rev. Father Martin, Rev. George Morice, Rev. G. W. Russell, Rev. W. H. Elton, John Plaisted, E. T. Robinson, Dr. James, D. McDonald, R. W. Wade, H. L. Robinson, W. D. Kerr, G. A. Paterson, Robert Walker; *Hon. Treasurer*—W. A. Spence; *Hon. Secretary*—John Anderson.

Office-bearers for 1879:—*President*—His Honour Judge Weston; *Vice-president*—R. C. Reid; *Committee*—Dr. James, Dr. Giles, James Pearson, R. W. Wade, E. B. Dixon, John Nicholson, H. L. Robinson, D. McDonald, W. D. Campbell, Robert Walker, A. H. King, T. O. W. Croft; *Hon. Treasurer*—W. A. Spence; *Hon. Secretary*—John Anderson.

Extracts from the Rules of the Westland Institute.

3. The Institute shall consist:—(1) Of life-members, *i.e.*, persons who have at any one time made a donation to the Institute of ten pounds ten shillings or upwards; or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half yearly meeting. (2) Of members who pay two pounds two shillings each year. (3) Of members paying smaller sums—not less than ten shillings.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

HAWKE BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1878:—*President*—The Hon. J. D. Ormond, M.H.R.; *Vice-president*—The Right Rev. the Bishop of Waiapu; *Council*—Messrs. Colenso, Kinross, Locke, Miller, Smith, Spencer, Sturm; *Hon. Secretary and Treasurer*—W. Colenso; *Auditor*—T. K. Newton.

Office-bearers for 1879:—*President*—The Right Rev. the Bishop of Waiapu; *Vice-president*—W. I. Spencer; *Council*—E. H. Bold, W. Colenso, J. G. Kinross, S. Locke, M. R. Miller, J. A. Smith, F. W. C. Sturm; *Hon. Secretary and Treasurer*—W. Colenso; *Auditor*—T. K. Newton.

Extracts from the Rules of the Hawke Bay Philosophical Institute.

3. The annual subscription for each member shall be one guinea, payable in advance, on the first day of January in every year.

4. Members may at any time become life-members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4.) The session of the Hawke Bay Philosophical Institute shall be during the winter months from May to October, both inclusive; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

TRANSACTIONS.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1878.

I.—MISCELLANEOUS.

Art. I.—*On some of the Terms used in Political Economy.* By John Carruthers, M.Inst.C.E.

[*Read before the Wellington Philosophical Society, 13th July,* 1878.]

Political Economy has been very unfortunate in its nomenclature, which has been drawn from the vocabulary of the mercantile world, every word of which, besides its direct notation, connotes more or less distinctly some economic doctrine. In spite of definitions, the secondary meanings of the several words have influenced the thoughts and teaching of political economists.

The object of this paper is to examine some of the principal terms in general use, and their definitions as given in Mill's "Principles of Political Economy," which is almost universally accepted as the best exponent of modern thought on the subject. I hope to be able to suggest others, which will not be so liable as those given by Mill to confuse the thoughts by suggesting a secondary meaning not included in the definition itself. Even should I not succeed my labour will not be thrown away, as it is always useful to look at scientific problems from more than one point of view.

Wealth.

Mill defines wealth to be "all useful or agreeable things which possess exchangeable value." To this definition it may fairly be objected that exchangeable value is a merely accidental quality of some things useful or agreeable, and should not, therefore, be treated as essential. Robinson Crusoe's cave and garden were just as much wealth as if he had been able to exchange them for other things. Exchangeable value is, it is true, a

very important quality in connection with the distribution of wealth, and should, therefore, be accurately defined and carefully studied, but it should not be treated as a specific distinction of wealth itself. Mill himself says (Book III., chap. i.), that "The conditions and laws of production would be the same as they are if the arrangements of society did not depend on exchange, or did not admit of it." Here "production" means the production of things which must, by the definition, possess exchangeable value; but if the arrangements of society did not admit of the existence of exchangeable value at all, how could the production of things possessing it be carried on? Again, he says: "Exchange is not the fundamental law of the distribution of the produce, no more than roads and carriages are the essential laws of motion, but merely a part of the machinery for effecting it." A definition, however, of motion, which made it dependent on the existence of roads and carriages, would be exactly parallel to a definition which makes wealth dependent on exchangeable value.

It is always undesirable to use a definition which pointedly draws the attention to any accidental quality of the thing defined, in such a manner that this quality may come to be regarded as essential. More especially is this the case when there already exists a tendency to regard the accidental quality as the only necessary and essential one. There can be no doubt of the existence of such a tendency as regards the exchange value of wealth. How many people look upon a short harvest as a not very great misfortune, because they think the high prices for which it is sold make up for the shortness of the crop? In one of President Grant's annual messages he congratulates his fellow-countrymen on the rise of prices in grain and pork which the Franco-German war had caused, and which he thought must be of great advantage to the United States. He evidently looked upon the rise in the exchange value of these commodities as equivalent to an increase of their utility, and that a scarcity of the necessaries of life was no real misfortune to the labouring classes of his country as long as it was accompanied by high prices. Where such opinions are held, even by men of education, it is surely well not to carelessly use a definition which gives a sort of plausibility to the error.

I propose to define wealth to be anything which is useful to man, by enabling him to live more comfortably or elegantly than he could without it.

Of the total wealth existing in a community a part is usually called capital. Unfortunately, this word has several different meanings in common language, and confusion and error have arisen from its being used in one of these instead of in its defined meaning. It sometimes denotes not actual wealth, but a right to a certain share of the wealth of the community.

Mill frequently uses it where it can have no other meaning than this notwithstanding that he has defined it to be "a stock previously accumulated of the product of former labour,"—a definition which scarcely differs from that given of wealth; for, except land and its natural productions, nothing possesses exchangeable value which is not the product of former labour.

Fixed and Circulating Capital.

Capital, again, is subdivided into "fixed" and "circulating." Mill's explanation of these terms, given in Book I., chap. vi., is too long for quotation, and is very far from being clear or exact. His summation is, however, that the result of a single use of circulating capital must be a reproduction equal to the whole amount of the circulating capital used, and a profit besides; and that with fixed capital, such as machinery, this is not necessary, as it is not wholly consumed by one use.

If capital means wealth of any kind, this sentence is absolutely without meaning. How can, for instance, the result of a single use of a sack of coals in a locomotive engine be a reproduction equal to a sack of coals and a profit besides? If, however, capital has the meaning above given, of a right to a share of the wealth of the community, the sentence becomes intelligible. The use of the coals must reproduce to the owner a right to some other wealth which he values more highly; and if the coals and the other wealth be both compared with a common standard of value, like money, the use of the coals must reproduce to the owner their price and a profit besides. Capital, with this meaning, can have nothing to do with the production of wealth except indirectly, and its subdivision into fixed and circulating does not seem to serve any good purpose in political economy.

There is, however, a natural division which cannot be disregarded. Some things, such as bread, wine, dwelling-houses, clothes, etc., etc., are useful for their own sakes; the production of these is the end and aim of all labour and sacrifice, or at least of all that falls within the province of political economy; they may be called direct wealth. Others are of no use for their own sakes; they are useful only by co-operating with human labour in the production of direct wealth; they are land, steam-engines, ploughs, coal when used to drive an engine, warehouses, etc., etc.; these may be called implements. Of course, neither direct wealth nor implements, if the product of human labour, are made complete at one operation; they first pass through the stage of materials, such as corn, wool, iron, wood, etc.; but it is not necessary to place materials in a separate class, as they may be classed with the final products of which they eventually form a part.

Whenever labour is devoted to the production of an implement, there is a sacrifice of present for future advantage. The sacrifice may be slight and the advantage great and almost immediate, but there is always *some* sacrifice. For instance, olive oil is direct wealth, useful for its own sake; if, instead of consuming it as food, the owner uses it as an implement to lubricate a steam-engine, he gets, as a reward for his slight sacrifice of present good, a vast return in labour saved. This is an extreme case at one end of the scale; at the other end, are improvements in land, where a sacrifice of the product of a year's labour of, say, thirty men, may be given in exchange for a future increase of the yearly harvest, equal to the product of one man's labour. A wealthy landowner in England would probably undertake such a work, as he would make 3⅓ per cent. interest on his outlay; but it would not follow as a matter beyond dispute, that the employment of the labour in this manner was to the advantage of the community at large, or that, if both the sacrifice and the reward were evenly distributed, it would be worth while to incur the one for the sake of the other.

Bearing in mind the division of wealth I have proposed, we may readily test the accuracy of the several statements made by Mill and other writers as to the effect of employing labour in the production of fixed and circulating capital (or wealth) respectively. It is stated that the increase of fixed, when it takes place at the expense of circulating capital, must be temporarily prejudicial to the interests of the labourers. This is not quite accurate: labourers' cottages would, under his definition, be fixed capital; but it would not be prejudicial to the interests of the labourers themselves to employ labour in building them; provided, of course, such employment were judicious—that is, that the cottages were required, and the still more urgent requirements of the labourers, food and clothing for instance, were already provided. The same may be said of workmen's club-houses, tea-gardens, theatres, taverns, and other places of use or amusement which workmen frequent.

It is also stated that "there is a great difference between the effects of circulating and fixed capital on the gross produce of the country," the context showing that the former is supposed to be the more productive. A steam-engine, for instance, is fixed capital, the coal which is consumed in it is circulating; the coal is, therefore, more productive than the steam-engine. Surely this is equivalent to saying that one shear of a pair of scissors does more work than the other. Although the steam-engine is fixed capital the iron of which it is made is circulating; and it is, therefore, a more productive employment of labour to manufacture unwrought iron than to make that same iron useful by putting it into an engine. The

absurdity goes even one step further; the steam-engine is circulating capital when it is still in the hands of the maker—at least I think Mill's definition would so classify it. When it is in the hands of the user and in full work it is clearly fixed capital, and therefore less productive than before it came into use.

These illustrations show how needless, or even mischievous, is the usual subdivision of wealth into fixed and circulating capital. The division I have indicated of direct wealth and implements is, however, natural and essential to an intelligent study of the laws which govern the production of wealth.

The sacrifice which is always made when labour, which would otherwise have been applied to the production of direct wealth, is applied to the production of implements, is made by the labouring classes. The whole wealth of the community belongs to part only of the individuals composing it. They apply a portion of their wealth to their own use, the rest they give to labourers to induce them to work for them. The reasons which induce them to employ part of their wealth in this manner, are not influenced by a resolve on the part of one of their number to produce new implements. When, therefore, new implements are made, capitalists do not take men away from the production of those commodities which they intend to use themselves; in other words, they do not lessen their own personal expenditure. They take men who would otherwise be engaged in producing commodities for the labourers, and, of course, less of those commodities are produced. This less quantity becomes the total fund to be divided between the labourers as wages. The owners of wealth as a body, without any personal sacrifice, become the owners of the implement; the sacrifice is made by the labourers alone and at once.

Generally, and perhaps always, except in the case of countries, which invest much wealth abroad, like England and Holland, the labourers suffer a further and still greater loss than the first cost of the new implements. The wealth-owners do not act as a body, but each individual acts independently of the others. Each man gives, of his own share of the general wealth, a certain portion annually to the labouring classes. When the implement was completed, no one would give more than before, while the man for whom it was made would give less; his gross share of the whole would be less than before by the whole cost of the implement, and he would give less by exactly that amount, as he would not reduce his own personal expenditure. There would thus be a general rise of profits, and a general fall of wages equal to the total cost of the implement, and this would continue for some years until the causes which had before fixed the relative proportions of

wages and profits had time to bring them back to what they were before the disturbance.

New and improved implements always increase the quantity of wealth which can be produced by the labour of the community, and the labourers share more or less in this advantage. Their interest is thus seldom opposed to the construction of new implements, although they bear the whole of the necessary preliminary sacrifice, and even in most cases a great deal more. In new countries, however, like New Zealand, the interests of the labourers and employers of labour are more often in conflict. If, for instance, a man can manufacture cloth for a little less than he can import it from England, it is his interest to employ his wealth in erecting buildings and machinery for the purpose. He gets thereby a small increase of his income. The labouring classes suffer for several years an annual loss equal to the entire cost of these implements, and derive only a small final benefit, as, by the hypothesis, the cost of manufacturing the cloth is only slightly less than that of importing it.

The cry for "protection to native industry," and consequently for increased expenditure on machinery and buildings, is perfectly rational on the part of colonial employers of labour. They gain, directly, the higher profits, for the sake of which they agitate for protection; and for every pound that is spent on implements, which would otherwise have been spent in producing direct wealth, they, as a body, get a pound a year out of the labourers, unless indeed they curtail their own expenditure, and thus pay for their machinery out of savings from their incomes. This they seldom do; machinery and buildings are generally made with money borrowed or taken out of some other business for the purpose.

Unfortunately, the labourers are generally so unskilled in political economy that they are as eager for protection as the employers. They see the employment that is given by a manufacturer, and do not see the much greater employment which would have been given by the same wealth had it been turned to other uses.

If they knew their own interests, instead of wishing to have nothing imported which can be manufactured in the colony, they would be loath to see any manufactory started which required expensive implements, if the article to be made could be imported at a cost not much exceeding that of manufacturing it in the colony. We, in New Zealand, are in so happy a position that we need not undergo the privation necessary to procure expensive machinery. The English are ready to do that for us, and are content with a recompense which we, in our more favoured circumstances, would consider inadequate.

Productive Labour and Capital.

The words productive and unproductive play a great role in the works of political economists. Nominally, they mean productive or unproductive of wealth—that is, of things useful or agreeable which possess exchangeable value—but when closely examined they will often be found to refer, not to wealth, but to a right to a share of the wealth produced by others; or, in other words, labour is sometimes said to be productively employed when it produces wealth, and sometimes when it only produces profits to the employer of labour. To distinguish between these two meanings I propose to use the words "productive" and "profitable," to mark the production of wealth and of profits respectively; and, unless otherwise stated, I shall use "capital" to denote, not wealth itself, but a right to a certain share of the wealth of the community.

A productive labourer is said (Book I., chap. iii., sec. 4) to be one "who produces more than he consumes." Let us take for example a navvy, who excavates ten cubic yards of earth and consumes in the same time a certain quantity of beef and beer. Has he produced more or less than he has consumed? Is he to be classed as a productive or an unproductive labourer? and if, instead of ten yards, he had only excavated one yard, would it have any influence on the classification? A shoemaker, again, makes a dozen pairs of shoes, and, while doing so, consumes a certain quantity of food and other things. He has produced the shoes, and must, therefore, be a productive labourer; but it is impossible to compare them with the things he has consumed, so as to say that his consumption has been greater or less than his production. There is no difficulty in finding out whether he is a "profitable" labourer or not. If he consumes less commodities than his employer can get in exchange for the shoes he makes, he is profitably, and, if more, then he is unprofitably employed.

Mill's illustration (Book I., chap. iii., sec. 4) of the results of productive and unproductive labour shows clearly that he really means profitable and unprofitable. He says:—"When a tailor makes a coat and sells it, there is a transfer of the price from the customer to the tailor, and a coat besides which did not previously exist; but what is gained by an actor is a mere transfer from the spectator's funds to his, leaving no article of wealth for the spectator's indemnification. Thus the community collectively gains nothing by the actor's labour."

Here the price of the coat is not wealth, nor anything which benefits the community or any member of it. The customer acquires the coat, giving to the tailor a piece of metal, useless of itself, but which gives him a right to a certain share of other people's wealth. This right he exercises,

perhaps, in buying food for himself. The community is not benefited by the transaction more than in the case of the actor. In that case the customer acquires a seat at the theatre, giving to the actor a similar piece of metal, with which he, like the tailor, buys food. Here, also, the community is not benefited; in both cases the customer alone gets the benefit; he acquires and applies to his own use the product of other people's labour.

A coat is not worn out by one use, and will last some months or years; but if the customer had, instead of a coat, taken a beef-steak and a bottle of wine, there would have been "no article of wealth left for his indemnification," precisely as would be the case if he went to the theatre.

It is stated in Book I., chap. iii., sec. 3, that "it is essential to the idea of wealth to be susceptible of accumulation; things which cannot, after being produced, be kept for some time before being used, are never, I think, regarded as wealth, since, however much of them be produced and enjoyed, the person benefited by them is no richer, is nowise improved in circumstances." This limitation of the meaning of wealth would exclude most of the articles used as food. Grain, vegetables, live stock, are not food; they are only the materials of which food is made. As soon as they are cooked and served for use they become food, but are no longer susceptible of accumulation.

To test the value of this definition we may take some examples: A painter is a producer of wealth, as he, with the help of the canvas-maker, produces commodities susceptible of accumulation. A poet, unless his works are printed, is an unproductive labourer; so is a musician. It will, I think, be readily conceded, that any classification is faulty which separates works so allied in general character as the productions of poets, painters, and musicians. An actor is emphatically an unproductive workman, and is always quoted as the example of the class; the dramatic author is also a non-producer; the theatre-builder is, however, a producer, because his work "can be kept for some time before being used." These three are, however, fellow-labourers, the finished product of their combined labour being an acted play: why should they be differently classed? If the actor does not produce wealth, the mason and carpenter who build the workshop in which his work is carried on must be also employed in producing something which is not wealth. The physician is a non-producer; but his fellow-labourers, the druggist, instrument maker, hospital builders, etc., are all producers; the labour of all is necessary to the work which they perform in common, and, in any classification, they should all go together. The public singer is at present a non-productive labourer, but if, as seems likely, the phonograph is ever so perfected that sounds may be stored up

and thus made articles of trade, he will become a productive labourer. Such an improvement in the phonograph would be, of course, a great addition to the wealth of the world. The labour of the singer, instead of adding to the pleasure of hundreds as at present, would give pleasure of a very high order to tens of thousands. The average happiness of man would be increased, but I do not see how the improvement would so change the character of the singer's labour as to convert it from unproductive to productive.

Throughout the whole of his chapter on "Unproductive Labour," Mill appears to have in mind, production of *profits* rather than production of *wealth*. The so-called unproductive labourers—authors, actors, public singers, lawyers, physicians, soldiers, sailors in the navy, civil servants, etc.—are men whose labour is as necessary to the well-being of society as that of any other class, but for the most part they work on their own account and are not dependent on capitalists. The product of their labour cannot be passed from hand to hand, and cannot, therefore, be made the instrument for acquiring a right to a share of the wealth of the community; it is, in short, not productive of profits or of capital.

Of all the products of labour, food is the most necessary, and may, therefore, most justly be called wealth. The community at large is not, however, enriched by the labour of the farmer more than by that of the actor or public singer. Without the farmer's labour the community could not exist at all, but without the actor's labour it could not maintain that average state of enjoyment in which it lives and to which the labour of both is equally necessary. The product of the labour of both can only be enjoyed once, and when once used is gone for ever.

Far too much stress is laid on the accumulation of wealth in most works on political economy, especially when discussing productive labour, and too little on the kind of wealth which can be, or at least should be, accumulated. We are unfortunately obliged to store sufficient grain for one year's consumption, but there would be no use in accumulating a stock sufficient for several years, unless, like Pharaoh, we anticipated a drought. So with clothing and all other forms of direct wealth; there is no advantage in having a large stock of them on hand. The makers and sellers of all kinds of direct wealth always strive to keep the stock in existence, and not in actual use, as small as possible, while the consumers take care that the stock in use shall not be needlessly large. No one has any interest or wish to acquire or keep a stock of commodities which will not be shortly consumed, or put into the consumers' hands for use.

Under the social system prevailing in all civilized countries, everyone

should in his youth accumulate capital, that is, a right to wealth which he himself has not produced, so that in his old age he may live in comfort without working; this is not, however, accumulating wealth, but only providing that the distribution of future wealth shall be made in a particular manner. The community never grows old; and it would be unreasonable, even if it were possible, that one generation should scrimp and spare so that the next should live without labour. Each generation provides for the future by rearing children. It does not lay aside wealth for future use, but stores it, by using it to feed the young, who in their turn support their fathers when no longer able to work. Unhappily, the machinery by which this is effected is very faulty, and age and want too often go together; but it is still true that all who are too old or too young to work are supported by those in the prime of life.

Direct wealth is never saved, but is consumed as fast as it is made, or is stored up so far only as may be necessary to make the stock in hand last until more can be produced. This can not be called saving at all; it is no more than the exercise of sound judgment in the rate of consumption. There is no sacrifice involved, but the reverse.

Saving on the part of the whole community can only be made by making implements; there is in this case a clear sacrifice, for the labour which is devoted to the work might have been employed in producing direct wealth, which would at once have been useful, while the implement only makes it possible that a larger stock of wealth shall in future be produced with the same labour.

The number of implements which can be judiciously made is, of course, limited by the number of men who are at hand to use them; it is also limited by the advantages which would be gained by having them; if a large expenditure would be incurred in making a new machine, and only a small increase obtained in the production of future wealth, the community would be richer by not making it at all. In a community where education and knowledge of the laws of nature are stationary this latter limit is soon reached, and no further increase of wealth is then possible.

There would have been for instance no use, just before the invention of railways, in making more macadamized roads in England, as those already made were sufficient, and any increase in their number, however large, would have been followed by only a small increase of utility. Increased knowledge of the laws of nature, by suggesting that invention, opened out a new way of employing labour in making new implements which would repay their cost. The result was a large increase of the wealth of the world, measured, not by the cost of the railways, but by their efficiency as compared with the roads they superseded.

From the language generally used by writers, it would almost appear as if they thought the usefulness of the "accumulated stock of the product of former labour" depended on the labour which was spent in producing it, and not on the facility it gives for producing future wealth, and hence too much importance is generally given to the durability of implements. If, in a community, a given number of machines is required to carry on its manufactures, say ten, each of which requires a year's labour of a hundred men to produce, and will just last ten years: at the end of every year one machine will be thrown aside as used up, and a new one brought into use; there will always be ten in use, each representing the labour of 100 men, so that the stored-up wealth of the community will be represented by the labour of 1,000 men for one year, and there will always be 100 men employed in making new machines. If, now, a new kind of machine be used, which is equally efficient, but will last only one year, and requires only ten men to construct: At the end of every year the whole ten machines are thrown aside and ten new ones put in their place. The total number of men employed in machine-making is, as before, a hundred. The community is no better off than before, and no worse off; the same number of its members are removed from the business of producing direct wealth. The amount of labour stored up is, however, represented by one year's labour of a hundred men instead of, as before, of a thousand. The "accumulated stock of the produce of former labour" has been reduced to one-tenth of its former amount without lessening the well-being of the community.

There are hundreds of steam-engines now being thrown aside which would last for twenty or thirty years longer, but it is better to make new ones of better design. The old engines cost as much labour to produce as the new ones, so that if the wealth of a community is to be measured by the amount of stored-up labour it possesses, there is no advantage in replacing old-fashioned machinery by new.

The exaggerated importance generally given to saving and accumulation in common estimation, and even by political economists, is due to the use of the word capital in a sense not covered by its definition. A capitalist is one who, without labouring himself, has a right to a share of the wealth produced by others. If he exercises his right in acquiring costly food and clothing for himself, and coarser food and clothing to give to servants to induce them to wait on him, his right is satisfied and thereafter ceases. He is said to have lived on his capital. If, instead of doing so, he uses only a part himself and gives the rest to labourers to induce them to work, some to produce articles which he himself will consume, and the rest to produce

food to maintain both themselves and the other labourers, he is said to invest his capital and to live on the interest. The more he gives to the labourers and the less he uses for himself, the more he is said to save. Of course there can be no limit to the saving of this kind which it is desirable that he shall make, short of his not keeping enough to maintain himself in average comfort. All that he saves is consumed by the workmen, so that the community as a whole stores up nothing. Both capitalist and workmen cannot save at the same time, except, as before said, by making new implements. If they both persist in refusing to consume the wealth produced, their barns would be filled with grain for the benefit of the rats, and their warehouses with cloth and iron for the moth and rust to corrupt; but they could not go on for ever in that way, and would have eventually to cease work. Any individual workman may save, that is, he may refrain from consuming his share and invest it, by giving it to his fellow-workmen who would consume it; but the whole body of workmen can only become capitalists by making new implements, unless other capitalists live beyond their incomes.

It must not be forgotten that implements are made for the purpose of being at once useful and not for the sake of storing wealth. If one generation gets any advantage from the labour of its predecessor, it is due to the accident that most implements, and some articles of direct wealth, are made of durable materials, and not to any saving made intentionally with the view of benefiting posterity. One generation, however, owes very little to its foregoers of the material wealth it enjoys. The greater part of the wealth of the community was made within the last year, and very little is ten years old. The accumulations we have received from our fathers, and owe to our sons, are knowledge of the laws of nature, good laws, and habits of labour. If these are increased, the means of producing material wealth are also increased; with the same labour our sons will be able to live better than we, unless their numbers increase so much that they cannot produce sufficient food without increasing the proportion of those employed in producing it as compared with the whole community.

Capital.

This word has not been as closely defined as its importance requires, nor is it uniformly used in its defined meaning. Mill says it is "a requisite without which no productive operations beyond the rude and scanty beginnings of primitive industry are possible." His first definition already quoted, makes it equivalent to all exchangeable wealth, except land and its spontaneous productions. With this meaning it is clearly an unnecessary word. Land is simply an implement, and does not require to be classed

separately from other implements; nor do trees and grass, which have grown without the help of man's labour, differ from those which man has planted or sown.

In Book I., chap. iv., sec. 1, it is thus further defined:—"What, then, is his (the capitalist's) capital? Precisely that part of his possessions, whatever it be, which is to constitute his fund for carrying on fresh production. It is of no consequence that a part, or even the whole of it, is in a form in which it cannot directly supply the wants of labourers." And again:—"The distinction between capital and Not-capital does not lie in the kind of commodities but in the mind of the capitalist—in his will to employ them for one purpose rather than another; and all property, however ill-adapted in itself for the use of labourers, is a part of capital, so soon as it, or the value to be received from it, is set apart for productive re-investment. The sum of all the values so destined by their respective possessors, compose the capital of the country."

The first objection to these definitions which presents itself, is that they would be unmeaning if there were not two classes in the community, one to whom the whole of its wealth belongs, and who may or may not, as they like, give any of it to the other class, who own no wealth and can only procure any by labouring for the wealthy class. The existing social arrangements under which this state of things almost necessarily exists, are not, however, essential to the production of wealth. The total produce of the labour of the community might be equally the property of all; there would then be no part set aside for productive re-investment. The whole direct wealth would be consumed as it was made, or at least given to the consumer to put into use. While it was being consumed, the community would be at work producing new wealth, which in its turn would be consumed. Can any part of this wealth be marked out and said to be the capital of the community? the part on which the production of future wealth depends? Food is, of course, necessary, and if an insufficient quantity were produced the community would starve and produce no more wealth; but if by capital be meant the necessaries of existence, why use so confusing a word when others, about the meaning of which no doubt can arise, are at hand? Except implements none of the other articles which were consumed or used were more necessary than another to production, and all must, therefore, be in the same class, either capital or not-capital.

Implements are essential to production, but no political economist has defined capital to be the stock of them in the country; land, the most important of all, is indeed pointedly excluded, obviously because the land-

lord's share of the common stock of wealth depends on different conditions than that of other capitalists.

It thus appears that in a communistic society there is no such thing as capital in the sense of a fund for carrying on fresh production, or of a fund set aside for productive re-investment. The material requisites of production are labourers and implements only. The necessaries of life are required, as are also health, strength and intelligence, to enable labourers to work—but they are connoted by the word labourer, and need not be taken into consideration. There is one immaterial requisite which must, however, be considered, namely, the effective wish that wealth be produced, that is, a wish strong enough to overcome man's natural repugnance to work.

In a rude stage of society this wish is so weak that man will only labour under the immediate spur of hunger; his repugnance to making other people work is not so strong, and he makes his wife and slaves work even where the return from their labour is somewhat distant; the rude beginnings of agriculture are always the result of woman's labour. It is doubtful whether there is, even now, a society so advanced in civilization that the production of wealth could be safely left to the average forethought of its members without the help derived from the pressure of immediate want. As society is at present organized, the great majority of the people, the labouring classes, are kept to their work by a pressure almost as strong as in the rudest societies; if they do not work to-day they will get no dinner to-morrow. In a commune, the punishment of idleness would be quite as certain but more distant. As long as the past year's harvest lasted they would be equally well fed whether they worked or not; the results of their idleness or industry would not show themselves until after the following harvest, when it would be too late to make good any past errors. The wish that wealth be produced need not be so strong as in a commune; for wealth will be produced if the capitalists wish it, and they need not themselves labour to carry their wish into effect; it is sufficient that they induce other people to labour.

The requisites of production are the same under present social arrangements as they would be in a commune; they are labourers, implements, and the wish to produce. If capital is, as it is stated to be, a requisite of production, it must be one or more of these, and is a worse than useless word, for it is never, in ordinary conversation, used with a meaning allied to that which would have to be given to it by definition.

It is impossible, by reading Mill's definitions as given in Book I., chap. iv., to get any clear understanding of what he really means by

capital; we will therefore examine his four fundamental propositions as given in chap. v., to see whether he means any or all of the three requisites of production above given.

His first proposition is, that "Industry is limited by capital," and conversely, "every increase of capital gives, or is capable of giving, additional employment to industry, and this without assignable limit."

The whole wealth produced by the community belongs to the capitalists. The labourers have no share in its ownership. Theoretically, the capitalists could store it in their warehouses and keep it for their own exclusive use, leaving the workmen to starve; practically, they do not, nor would they be allowed to do so. It is their interest to keep only a certain share for themselves, and to give the balance to the workmen to induce them to work for them and produce new wealth. If they acted together as a class, or if no individual capitalist wanted to get more than the share he was already entitled to of the total product, they need never give the labourers more than the bare necessaries of life. All that could be produced beyond that, they might themselves consume. The labourers would then be divided into two classes; one engaged in producing the necessaries of life for themselves and for the other class; the other engaged in producing luxuries for the rich, and new and improved implements, which would still further increase those luxuries. It is obvious that if the wealthy then reduced the share of wealth which they gave to the producers of necessaries, some of the labourers would starve, and industry would thus be lessened as the number of labourers was lessened. The theorem is correct only when the conditions are such as are here indicated, when the labourers get only the bare necessaries of life, and when capital means these necessaries. Industry is then limited by capital, but not otherwise.

Fortunately, capitalists do not act together as a class; each individual tries to get more than his allotted share of the wealth of the community, and all try to entice workmen from the others by giving higher rewards, that is, they "employ more of their capital in reproductive investment." The result is not, however, an increase of industry as stated in the theorem, but higher wages for the labourers.

The second theorem is, that "Capital is the result of saving." The meaning of saving in this sentence is not that which it usually bears. It means the saving made by the capitalist, that is, giving to the working classes some of the wealth which the capitalist might, had he so chosen, have consumed himself. He says, by way of illustration of the theorem,— "If all persons were to expend in personal indulgences all that they produce, and all the income they receive from what is produced by others,

capital could not increase." The community as a whole does, however, practically consume all that it produces. If population is stationary, nothing more is required to increase the average wealth than to replace all worn-out implements with new ones of a more scientific kind. If population is increasing, the number of implements must be increased as well as their quality improved, in order that the larger population may labour more advantageously than the smaller had done. This would not in the ordinary meaning of the word be called saving; if the community increases, it is part of its current expenditure to provide the new members with facilities of producing wealth for their own support.

The meaning of "capital" in this case appears to be the wealth which the capitalists give to the labouring classes in exchange for their labour; and the theorem is little more than an identical proposition.

The third theorem is, that "Capital, although saved and the result of saving, is nevertheless consumed." This follows from what has been already said; everything which is saved by the capitalist is consumed by the labourers, except new implements, the production of which may be called saving by the whole community, as it implies a sacrifice of present for future advantage. All that Mill deduces from it does not, however, follow. He says: "Saving, in short, enriches, and spending impoverishes, the community along with the individual; which is but saying, in other words, that society at large is richer by what it expends in maintaining and aiding productive labour, but poorer by what it expends on its enjoyments." Saving by the capitalist, as has been so often said above, enriches the workman, but saving by the community would enrich no one. The object of labour is the bettering the conditions of life, and the community, therefore, is the *richer* by what it expends on its enjoyments, and not the poorer; it is the richer by what the capitalist saves, simply because this kind of saving is only another name for more equal distribution.

The community does not require to save; it requires only that its labour shall be wisely directed, so that the produce shall give the greatest possible comfort and enjoyment. If the necessaries of life are not produced in sufficient quantity it will suffer privation, although every man had been engaged in what is generally called productive labour; no amount of cloth or iron would make good the want of food. The necessaries having been first provided for, the common labour should be devoted to producing those luxuries which all can share. This is the "productive labour" which it is the interest of society to "maintain and aid." An actor or public singer may more properly be called a productive labourer than a velvet-maker or diamond-digger, because the enjoyment which his labour pro-

duces is shared by a larger number. As nothing can be done without implements, the stock of these must be kept up, and whenever increasing population or increasing knowledge makes it possible to do so with advantage, it should be increased. Care must, however, be taken that the future advantage shall not be purchased at the cost of an undue present sacrifice.

The fourth theorem is, that "What supports and employs productive labour is the capital expended in setting it to work, and not the demand of purchasers for the produce of the labour when completed. Demand for commodities is not demand for labour. * * * * The maintenance or payment of labour depends on the amount of capital or other funds directly devoted to the sustenance and remuneration of labour." The main deduction from this theorem is, that a capitalist, by buying velvet or other commodity for his own use, does not improve the circumstances of the working classes, but that by employing gardeners, grooms, and other retainers, or by giving alms, he does so. The error contained in this deduction unfortunately pervades Mill's work, and makes that part of it which treats of the production of wealth far less valuable than that which treats of its distribution.

If two capitalists, A and B, are entitled to equal shares of the wealth of the community, and both invest their shares from year to year, the working classes will receive the whole product of their own labour; A and B will receive none of it. If they retain for their own use a certain proportion which we may call interest, and invest the balance, the labourers will receive, not the whole, but a part only, the part received from A being equal to that received from B. Let us now assume that both resolve to consume the whole themselves; A deciding to take his share in the form of attendance on himself, while B decides to procure velvet; the wealth which had been produced by the labourers they had previously employed must in both cases be again given to the working classes; in A's case it goes to grooms and footmen; in B's case it goes to velvet weavers. When the wealth is all consumed, the labourers get no more from either A or B; A has received the share of wealth he was entitled to in the form of the services of his attendants, and having done nothing to entitle him to any share of future wealth his right lapses. B gets a certain quantity of velvet which he uses for his own pleasure, the labouring classes get no benefit from it, and, as in the case of A, his right to a share of future wealth also lapses. It is obvious that in both cases the labourers receive precisely the same advantage; A has done no more good than B.

If A had not come to the selfish resolve to apply his wealth to his own

use, until a year after B had done so, he would have invested it, and the working classes would have enjoyed the use of it once more, receiving thereby a further benefit. He would then enjoy the services of his attendants at the same time that B was *wearing* his velvet, and not, as before, at the time B was *manufacturing* it. Mill's error consists in thinking that, in this latter case, the actions of A and B are parallel, and that both were using contemporaneously their right to the product of the labour of others. A definition of the word "invest" would have prevented this mistake.

The capitalists, as a class, have absolute power over *future* production; whatever they wish to be produced will be produced; but they have no power over the past; the stock of wealth in existence is the result of their past wishes and actions, and cannot be altered. If any capitalist resolves to "invest his wealth," he means to give it to the working classes, and to continue to give them the result of their labour, keeping for himself only a part, which he calls his interest. He will so dispose the labour over which he has control, that it shall produce for himself the particular commodities which he wishes to use, and for his labourers the particular commodities which they will require. It may be more convenient that he shall arrange to produce for some other capitalist a different commodity, while the other capitalist produces what he requires, and that they shall exchange their respective productions. This would have no influence on the total wealth produced, which will be the sum of all the different kinds of wealth which all the capitalists require. Of course, in a large community there is no previous bargain made as to what each capitalist shall produce. They all anxiously forecast what their fellows will require, and direct the labour under their command accordingly; the result is, that taking one year with another, everyone gets exactly what he wishes. If any particular capitalist, after he has influenced the disposition of the year's labour of the community, changes his mind, and wishes to consume, himself, the share of wealth which he had previously determined to give to his labourers, he will be unable to do so. He may, by outbidding a fellow-capitalist, procure for himself what had been manufactured for his colleague, who will thus be deprived of it, but the labourers will be uninfluenced. The capitalist who was outbid will have on his hands, instead of the particular commodity which had been produced to gratify his wishes, a stock of goods suitable for the labourers, which he can only turn to account by giving it to them in exchange for the product of their future labour. If the first capitalist is not prepared to outbid his fellow, he must wait for a year before his new wish can be gratified, and in the mean time his labourers will get the benefit of

his former determination to invest his wealth. The result of a sudden resolve, on the part of one capitalist, to squander, thus appears to be, to induce another capitalist to save; on the other hand, a sudden resolve to save would in the same way induce an equal expenditure on the part of some one else; in either case the working classes are not affected.

A resolve, to have influence on the community at large, must have been made a year beforehand, when it could influence the future supply of commodities.

The word year here means, not a solar, but what may be called a manufacturing year; that is, the time which must elapse before the resolve on the part of a capitalist to produce any commodity can bear fruit. In the case of grain, wool, cotton, and other important agricultural products which form the main wealth of the world, it is equal to a solar year; however much capitalists may wish to increase the total stock of these, they cannot do so before next harvest. For most other things the year is shorter; if more iron or coal is wanted than has been produced, more men can be employed in producing it, and the stock thus increased pretty quickly. There are, however, many practical difficulties in the way of any great and sudden increase of the production of any particular commodity, and the manufacturing year is, perhaps, on the average not less than the solar.

To return to our former illustration: When A resolves to employ retainers he can do so at once, because his past resolve, which influenced production, gave him the food and other necessaries which he could give to the labourers to induce them to wait upon him. B could not at once wear velvet, because his past resolve was not that velvet should be produced, but that commodities suitable for workmen should be. These were produced in obedience to his wish, and he can only turn them into velvet by giving them to weavers to induce them to produce the velvet for him. If he does procure velvet at once, as Mill supposes, he can only do so by taking from some one else the share of it, which he had willed to be produced, and by giving him in exchange the commodities suitable for workmen, and these the workmen would in the end receive.

In short, a capitalist *expends his wealth* whenever he gives it to workmen to produce any commodity which he will himself consume; it does not matter whether the commodity be capable of accumulation, like velvet, or incapable, like a song or the services of a footman. The expenditure begins when the workman begins to labour.

He *invests his wealth in wages* when he gives it to workmen to support them while producing commodities which he neither intends to consume

nor to exchange for others which he will consume. He intends that the work produced shall be consumed by the workmen themselves, and it must therefore be of such description as workmen generally use. The wealth so given to the labourers may be called the "invested fund."

He "*invests his wealth in implements*" when he induces labourers to make them. It is absolutely necessary that implements shall be made, and it would therefore be absurd to say that it is any special hardship for the workmen to be obliged to produce them; but there is a good deal of analogy between wealth expended, and wealth invested in implements. In both cases the capitalist becomes the owner of the product of the labour, and the workman does not, as in the case of invested wealth, get any direct benefit from it.

He *exchanges his wealth* when he gives a commodity, or a valid certificate of a right to a share of the common wealth, such as cash, mortgage, book debt, or bank credit, in exchange for another. This form of transaction is generally looked upon as most important, but to the community at large it matters very little whether A owns a ship and B a farm, or B the ship and A the farm.

Mill (Book I., chap. v., sec. 9) speaks of a capitalist "expending his income in buying velvet or lace," as if this were the same as expending his income in producing it. The confusion between the two expressions has grievously misled him. The mere exchange of gold for velvet is of not the slightest importance to the community. A owned gold and B velvet; they make an exchange, and B then owns gold and A velvet. No one is in the least influenced except themselves. If A *produces* gold, or B velvet, for his own use, he applies the labour of the community to his personal advantage; if he is a mere agent, and C or D is the real user, then C or D gets the benefit, and expends his wealth in producing the velvet.

The foregoing examination shows that Mill does not use the word capital in any one fixed sense, but glides almost imperceptibly from one meaning to another. It is not, when used with any meaning he gives to it, a requisite of the production of wealth; these are labourers and implements only.

Its common meaning is that in which I have used it—the share of the direct wealth produced by the labour of the community, to which any capitalist can make a valid claim. The owner of implements, cash, mortgages, or any other form of acknowledgment of indebtedness, is called a capitalist, because by means of these he can make good a claim on the common stock of direct wealth, and not because he owns the things themselves which are not directly useful to him or to anyone else.

Capital in this meaning is of so much importance that some further examination of it is required.

The capitalists, who are the owners of the whole of the wealth of the community, must give some of it to the workmen to induce in them an effective wish to produce a further supply; the wealth so given forms what may be called the wages fund. As it is greater or less compared to the numbers of the workmen, wages will be high or low.

The wages fund embraces all wealth which is being "expended" (as before defined), that is, which is being given to labourers, who are employed in producing something which the capitalist will himself consume; as well as that which is being "invested." The present prosperity of the labourer depends on it alone; but that prosperity will only last the year, unless the "invested fund" forms a large proportion of the total wages fund. Next year's prosperity depends on the "invested fund," which will produce the wages fund of next year, since the capitalists have placed all that it is instrumental in producing beyond their own reach, in so far as they have willed that it shall be in the form of those commodities which workmen generally use. Future prosperity will depend on the future actions of the capitalists; if they resolve to expend their wealth for their own gratification, the labouring classes will not suffer during the following year, as they will then be as fully paid for producing commodities for the capitalists' use as they had been before. Their privations will not begin until the second year, when the capitalists will keep for themselves all the wealth produced by last year's labour.

If an individual capitalist is content not to consume a larger proportion of his share of the common wealth than the average of his fellows, he will be able to enjoy that proportion every year, and still keep good his claim to the proportion of the whole year's produce to which he was originally entitled. The part he consumes is often called the interest on his capital, and the part he invests, capital. By a false analogy, it is generally supposed that the wealth of the whole community is also divided into capital and interest, and that if the community consumes more than its interest it encroaches on its capital, and is on the downward road to ruin. An article lately appeared in the London *Times*, which argued from some manipulation of that bugbear of political economists, the returns of exports and imports, that England was "expending its capital," and, like a spendthrift squire, would soon be ruined unless she retrenched. Ruin to the squire would mean that in future the poor fellow would have to work for his living, and it would be hard to say when England was not in that unhappy state.

It is also commonly supposed that a spendthrift who expends his capital in one year, does more direct harm to the working classes than a wealthier man who expends as large a sum out of his interest; there is a feeling that in the one case capital has been destroyed, and that on capital the well-being of the workmen depends, while in the other case the capital which produced the interest is still intact. There is, however, no difference, except indirectly, in the two cases. Both consume certain wealth, which, had they not consumed it, would have gone to the working classes. It makes no difference to the latter whether what they want and would have had, if it had not been taken by some one else, is taken by A or by B; nor is their future stock of wealth at all influenced, for the men who were employed in producing the commodities consumed by prudent B were just as much taken away from the production of goods to be used by workmen, as were those employed in producing for spendthrift A.

When a spendthrift squanders his wealth he ceases to be a capitalist, but the others acquire the share which he has lost. The whole class owns between them all the wealth produced. If one of their number falls out of the ranks it is so much the better for the rest; on the other hand, a capitalist who increases his share by saving and investing a larger proportion of his gross share than the average, acquires his right at the expense of the others. He benefits the working classes, not only directly by increasing their wages, but also indirectly, by compelling other capitalists to be more frugal so as to maintain their proportionate share of the future stock; the spendthrift injures the working classes directly by consuming the wealth which they have produced, and also indirectly, by making it easier for the average man to keep his position as a capitalist, and thus keeping up the rate of interest.

It is the interest of the capitalists to give as little as they can to the labourers, and to receive as much from them as possible, consistently with their attaining other objects they have in view. As a rule, while they wish to live comfortably or luxuriously themselves, they also wish to leave to their heirs a right to a share of the common wealth, not less than that which they themselves enjoy. If they live too abstemiously, they increase the share to which they are entitled, but exercise a self-restraint which, under the circumstances, they consider unnecessary; if they live too well, other more abstemious men will push them from their stools, and acquire, to their loss, a right to the wealth produced by the community. In order to hold their own they must conform their personal expenditure to that of the average of their fellow-capitalists.

Capitalists are not necessarily men of more than common intelligence,

nor more likely than others to take a wide view of their own interests. They do not try to get more profit out of their steam-engines by stinting the supply of coal, or out of their horses or cattle by stinting their food, but they will, if they can, reduce wages to a point at which the labourer can barely live and work. They forget that a real and active desire that wealth shall be produced is one of the requisites of production, and that this cannot be entertained by a spiritless, hopeless drudge, who by hard and continuous labour can scarcely live better than the paupers in the workhouse, into whose ranks he must fall as soon as, broken down with rheumatism and other ailings brought on by insufficient food and shelter, the few best years of his wretched youth are passed.

The total wages fund does not depend on the supply of labour, but on the competition between capitalists, and will be the same whether wages are high or low. The rate of wages depends on the numbers of the workmen who share the wages fund. Where the community is divided into capitalists and labourers, the latter have scarcely any inducement to keep down their numbers, or rather, it is not so apparent as in the case of the capitalists, and they are not fitted by education or habits of thought to exercise self-restraint when the reward is distant and not very obvious. They, therefore, tend to multiply until the wages fund is not more than sufficient to give them the bare necessaries of life. If the capitalists avail themselves of the competition of the labourers against one another, they may pay their workmen no more than is just sufficient to keep body and soul together. It is not their real interest to do so; by doubling wages they would induce the men to work so much better, that the produce would be increased in a still higher ratio. They should, even in their own interest, refuse to pay less than a certain liberal rate; the wages fund would then maintain only a comparatively small number of labourers, and an efficient check would be at once placed on undue increase of population.

We have a right to expect more from capitalists in return for the immense privileges we grant them, than a simple acquiescence in the course which events are taking. If they cannot prevent a country from falling into the state into which Ireland fell, or even into that in which the south-west of England now is, they are of no use, and the sooner they are abolished the better.

No other servants of the State, which capitalists simply are, would be tolerated who were so highly paid, and who performed their work so badly. We leave in their hands the absolute disposal of the labour of the community, and the distribution of the wealth produced by that labour; we

allow them, within wide limits, to fix their own wages, only requiring them in return to conduct their operations so as to give themselves the largest profit they can make. The only argument which can be used to justify such a trust is, that in striving for the interests of themselves, they, if they use thought and self-restraint, are likely to do better for us than we could without their help. The failures they have made would fairly justify the community in trying to do without them; it is scarcely likely that worse disasters would follow than the Irish famine, or the long years of hopeless misery which preceded it. The subjects of King Tawhiao or Sitting Bull are far better off than the poorest classes of Ireland, or even of England.

It is a very important social problem to ascertain what is the rate of wages which would give, in any geographical area, and under existing conditions, the largest return to the capitalists (excluding landlords) as a class. If this were known, public opinion among them would probably prevent anyone from offering a lower rate, and it is almost certain that the labourers of all the older countries of the world would be bettered in circumstances by getting this minimum instead of their present wages. Notwithstanding the falling off in the population of Ireland since the famine, and the higher rate of wages now paid, there is no doubt whatever that the capitalist class gets a larger return than they used to when the rate of wages was only from fourpence to sixpence a-day.

The number of hours which a man must work during the day in order that the produce shall be a maximum is also unknown. Capitalists would seem, from their actions, to think that it is not less than fourteen or even more. Some information may be gained from the public works carried out in New Zealand during the last few years. The average rate of wages for unskilled workmen has not been less than a shilling an hour, the men working eight hours. In England the rate is, or at least was, a few years ago, about threepence an hour, the men working twelve hours; the cost of earthwork should be, if the work done were proportional to the number of hours in a day's work, four times as high in New Zealand as in England, but it has averaged considerably less than twice. This is a very rough test, but it tends to strengthen the opinion held by many intelligent employers of labour, that a man will do more when working eight than he will when working twelve hours a-day.

Interest.

As before said, that part of the national direct wealth which capitalists keep for their own use is called interest; it is the reward they receive for investing their wealth, instead of expending it.

As new men are continually, by frugality, making good a footing in,

and others, the spendthrifts and prodigals, are dropping out of the list of capitalists, the average rate of interest tends, even when the population is stationary, to become lower, to approximate more closely to what will satisfy the more frugal part of the class.

As population increases, and it becomes necessary to cultivate inferior land in order to produce a sufficiency of food, the average effectiveness of labour tends to decrease, and the rents of the landlords to increase, the labourers can then, besides making new implements, produce little more than is sufficient to maintain themselves and to pay the landlords. The temptation to expend wealth instead of to invest it becomes greater, and in the struggle for a position the smaller capitalists are gradually pushed out of the ranks by the larger, who can, with less sacrifice, afford to invest a larger proportion of their capital.

There is thus a tendency of wealth to fall into the hands of a few, and the extremes both of riches and poverty are generally found in the same community.

In an extreme case, the number of capitalists may become so small that a practical combination may occur amongst them to reduce the wages fund; and something like this appears to have taken place in the later years of Rome.

Those who share the interest fund are the owners of money and land, the fund-holders, and those whose wealth, invested either in implements or wages, had been instrumental in its production.

The owners of that large stock of wealth which is in the hands of the consumer, dwelling houses, furniture, clothes, etc., do not share in it, nor do the owners of goods manufactured for the use of capitalists. The velvet manufacturer, for instance, gets no interest on his velvet; it is the product of "expended" wealth. As a rule, he would not himself be the consumer of his own manufactures; he has only manufactured them so as to procure other goods which he requires; the velvet was made because other capitalists had so willed it, he knowing from former experience that they had done so, and that, in the same way, whatever he willed to be produced would be duly provided. If he intended to invest his wealth, others would provide the commodities which he requires to give to his workmen, and he will be able to get these in exchange for his velvet. He has, it is true, "expended" his wealth in making a commodity for the use of capitalists, but by so doing has induced those capitalists to "invest" theirs in making goods for the future use of his labourers; by exchange each gets exactly what he wants, more conveniently than he could otherwise have done. If there had not been a prospect amounting to a certainty that this

exchange would take place, the velvet consumer would have manufactured the velvet he required, and the velvet manufacturer would have made the commodities for workmen which he required. The essential part of investment does not consist in what is actually manufactured by any capitalist, but in what he *wills* shall be manufactured for him, his will being equivalent to an order given to the makers. As long, however, as the velvet remains in the hands of the maker, he cannot invest it; he must exchange it for other goods, and, when exchanged, it comes into the user's hands, when it is of just as little use to the working classes as the past services of the same user's footman.

It would be impossible to adjust the claims of the various capitalists without the help of a common measure of value, and throughout the world gold and silver have been adopted for the purpose.

The capitalist measures his wealth in money; it is the quantity of gold he has, or which at current rates he could get, for the particular thing on which his claim to a share of future wealth is founded. The only capitalists who help, directly, in producing wealth are those who invest either in wages or implements, and the capital of each individual is measured by the current price of his implements or of the food and other things which he possesses. The money owner, indirectly, facilitates production, and his capital is measured by the gold he owns. The landlord and fund-holder do nothing towards production, but as they share in the product, their possessions have, on that account, exchangeable value and therefore a market price. If the money value of the possessions of these five classes of capitalists were added together, it would form what might be called the capital of the country, if the term were not so likely to suggest other and different meanings. The share of the interest fund which any capitalist could apply to his own uses without lessening his future share bears the same proportion to the whole that his capital bears to the total capital of the country.

The expression "capital of the country" is often used to represent that part of the wealth of the community on which its prosperity and well being are supposed peculiarly to depend, but as in all other cases in which the word capital is used, there is great vagueness as to the meaning which is intended to be conveyed.

In estimating its value, the price of land and of the national debt is often included, but the interest of these is simply a tax on the community at large, and cannot in any sense be said to further the general prosperity.

Money also should not be included. It consists largely, and might consist entirely of paper, which costs nothing. Our just distrust of the

honesty of governments is the only reason why gold should not be given up as the medium of exchange and bank notes substituted, the number issued to be limited in accordance with a fixed and unvarying rule. The whole of the enormous expense of gold-mining would be saved to the world and the existing stock of gold made available for use in the arts. In any case, whether it consists of metal or paper, money has no intrinsic worth, being a mere implement to assist in the distribution of wealth.

Implements should also be deducted; their costliness is not an element of prosperity but only an indication of past privations. Their efficiency does influence production, but cannot be valued in money, as it is the result of thought and knowledge, as well as of labour. The engines of one of the Cunard steamers of the present day cost no more labour to produce than did those of five-and-twenty years ago; they will, however, develope the same horse-power with one-third of the cost of coal and repairs. As far as they are concerned the "capital of the country" has trebled, but no indication of the increase would appear in a return of the machines in use and their cost.

In short, there is no means of comparing the prosperity of two different countries or the same country at different times. Present prosperity depends on the stock of direct wealth in actual use or stored ready for use, and on the number of men, such as actors and singers, employed in producing for the immediate gratification of the community enjoyments not capable of being stored. Future prosperity depends on the number of men who are employed in producing a further stock, and in the efficiency of their labour. The only further requisites are, that the choice of things to be produced shall be judicious and their distribution moderately equal.

A large part of capital consists of what is generally called floating capital. Its ownership is attested by bank accounts, promissory notes, and other acknowledgments of indebtedness. At first sight it would appear that this was not included in any of the forms above enumerated, but the owners of floating capital really own a share of the wealth nominally owned by those who are indebted to them; they do not, as is generally supposed, own money of which the supply in existence is comparatively small.

It has been assumed throughout that the owner of capital applies it with average skill and energy, in such way as shall give him a right to share in the future wealth; the implement-owner must take care that his machines are kept fully employed; the employer of labour must keep his men to their work, and must direct their labour judiciously; the landlord must find tenants or farm the land himself; the fund-holder has nothing to do but to draw his dividends when they become due—his claim is the reward of

past services done to the community. The money owner has a very peculiar duty, as he has only to see that he keeps no more of it on hand than is required. If a banker keeps a larger reserve than he needs, he will not get the average banker's interest. He gets no interest, directly, on his gold reserve, but the profit on his other transactions is larger on account of it. If it is unnecessarily large, he, of course, loses the interest on all the money he needlessly keeps. This is also true of the merchant and manufacturer. The consumer who keeps money in hand to meet current expenditure gets no interest for it.

A capitalist who uses his capital unskilfully benefits all other capitalists and injures the community at large, except in the case of a money owner, who injures no one, except himself, by mismanagement. If he keeps more on hand than the nature of his business requires, the stock in the hands of others becomes more valuable, by the exact amount of his excess, and the smaller amount in circulation is quite as efficient as the larger would be.

Cost of Production.

The cost of production of any commodity is simply the labour required to produce it; it does not matter whether the labourer be a Millais or a coal-heaver. Wealth being required, there is only one way of getting it, and that is by labour, and the labour of all is equally necessary to the production of the common stock. The problem to assess the utility of each man's production would be quite insoluble. There would even be a difficulty in deciding whether a day's labour of Turner or West, or of Browning or Tupper, were worth most. It would be easier to assess the relative value of two navvies' work, one of whom could dig ten and the other only five yards of earth in a day. Even in this latter case the labour of both men would be equally requisite to the production of the total stock, if it were necessary to dig fifteen yards a day. A capitalist must take into account not only the labour which was required to produce his wares, but also the rate of wages he was obliged to pay his workmen, and the interest he would be obliged to pay to other capitalists; from his point of view, therefore, both interest and wages form part of the cost of production.

It would be well to keep distinct what is essential under all circumstances from what is due to the accidental conditions under which society may happen to regulate its labour; and as a medium of exchange, like money, is necessary in a community divided into capitalists and labourers, I think the capitalists' costs of production should be called the "*price of production.*"

The exchange value of wealth tends to be in proportion to its price of production and not to its cost.

[NOTE.—Mill makes a note that the reviewer in the *Edinburgh Review*, (October, 1844), suggested a definition of implements very similar to that which I have proposed, but I have not been able to procure a copy of the review. See Book I., chap. ii., sec. 4.]

ART. II.—*On Antarctic Exploration.* By C. W. PURNELL.

[Read before the Otago Institute, 14th May, 1878.]

IN a presidential address delivered to the members of this Institute, in February, 1875, Mr. J. T. Thomson cursorily alluded to the subject of antarctic exploration. This subject had been under my own notice for some time previously, and I should probably have asked permission to read a paper upon it but for Mr. Thomson's remarks, which seemed to render it needless for me to do so just then. Other persons, I dare say, have had their attention directed to so fascinating a topic, although, after searching such official records of the proceedings of the different Philosophical Societies in the Australian colonies as are available, I have been unable to discover any paper dealing with it, or any allusion whatever to the matter, save that contained in Mr. Thomson's address. Yet it seems to me that there is no subject better fitted for the consideration of a scientific society in these colonies, and more particularly of the Otago Institute, than the best means of exploring the South Polar Seas. They form a weird and strange region almost unknown to man. They have been unvisited by any exploring expedition since 1843; and no discoveries appear to have been made by whaling vessels, or at all events none have been recorded, to supplement those of Sir James Ross; so that, while during the last five-and-thirty years our knowledge of the North Polar region has been immensely augmented; while Africa has been crossed and re-crossed; while the telegraph line has been carried over the then unknown interior of Australia, absolutely nothing has been done towards clearing up the mystery which enshrouds the regions lying within the antarctic circle. It has been estimated that a portion of the globe, three times the area of Europe, here lies unexplored. The entrance to this field of enterprise, too, is within a few days' steam of Otago.

It is of the highest geographical importance to know whether an antarctic continent exists or not. Cook's researches in the latter part of the eighteenth century dispelled the old belief in a *Terra Australis*, but

subsequent discoveries revived the idea in a modified form, and it is so long since anything was done towards exploring the antarctic regions, that a hazy notion that a mass of land surrounds the South Pole seems again to be diffusing itself, and we frequently find "the antarctic continent" spoken of as though it were an ascertained fact, whereas its existence is a mere hypothesis, although not a groundless one. What has really been discovered are three large tracts of land, many islands, and two or three pieces of land which may either be islands or the outlying points of a continent. The longest and best known of the three large tracts just mentioned is that lying to the south of Cape Horn, its various parts being named respectively Louis Philippe Land, Palmer Land, Graham Land, and Alexander Island. It is fringed with islands, of which the South Shetlands and the New Orkneys are the principal groups. In the same hemisphere, but due south of port Dunedin, lies Victoria Land, discovered by Sir James Ross in 1841, the coast line of which was further explored by him in the following year. This land is remarkable for being the site of an active volcano, 12,367 feet high, named by Ross Mount Erebus. It is situated in the high latitude of 76° 6′ S., and is in the vicinity of an extinct volcano, called by Ross Mount Terror. Ross traced Victoria Land from the 70th degree of latitude to nearly the 79th, the precise latitude attained by his ships being 78° 10′ S., or nearly four degrees higher than any navigator had reached before. It would appear that Victoria Land, to the south of New Zealand, forms a sort of bight; but what checked Ross's progress, and prevented him ascertaining the precise contour of the land at this latitude, was a solid barrier of ice, without flaw or fissure in its face, from 100 to 300 feet high, trending to the north and east. He sailed along this barrier for 450 miles, without being able to find an entrance or to see any land rising behind it during a great part of the distance, so that, although Ross himself seems to have been of opinion that the barrier screened a body of land, it cannot be positively asserted that such is the case. Victoria Land, may either at the point where Ross met the barrier, trend to the South Pole, or it may, covered by the ice barrier, stretch away to the eastward to meet Alexander Land, between which and Victoria Land the only known Land is Peter 1st Island, on the 91st meridian of west longitude, discovered by the Russian navigator, Bellingshausen, in 1821.

Turning now to the westward and south of Australia, we come to the important discoveries of our countryman Ballemy, the Frenchman D'Urville, and the American Wilkes. These consist of the Ballemy Isles, Sabrina Land, and Adèlie Land. The two latter form a coast line, if we are to credit Wilkes, extending from 154° 27′ E., to 97° 30′ E. long.; but Wilkes's

authority is not of the best, since he seems to have seen a great deal more than sailors of other nationalities could do. Indeed, Ross actually sailed over one spot where Wilkes affirmed that he had discovered a chain of mountains. Without, however, placing too much reliance upon Wilkes's alleged discoveries to the westward, we have the concurrent testimony of himself, Balleny, and D'Urville, that an extensive tract of land does exist in this direction; Balleny Isles, lying considerably to the eastward (lat. 66° 44′ S., and long. 163° 11′ E.), and so forming a connecting link between these and Ross's discoveries. It is noticeable that Cook, on his second voyage, was unable to get so far south as this body of land by four or five degrees, being stopped by the ice, although he was on the right track for its discovery.

Still proceeding westward, we next meet with Kemp Land on the 60th, and then with Enderby Land on the 50th meridian. These were discovered by our countryman Biscoe, in 1831–3. Whether Kemp and Enderby Lands are islands, or the outlying parts of a large mass of land, we do not know; but it is noticeable with respect both to them and the discoveries just mentioned that they all lie adjacent to the antarctic circle.

I have now summarised all that is actually known of the so-called "antarctic continent," from which you will see that, while there are indications which might lead us to infer a connection between the principal discoveries that have been made, it may well be that the most extensive of these lands are only the chief members of an archipelago. Each hemisphere offers its special attractions to the explorer. In the western, the vast space between Ross's discoveries and Alexander Land, extending over about 60° of longitude, remains to be examined. Cook tried to penetrate its recesses, but could get no farther than 71° 10′ S., which he did on the 107th meridian, when he was beaten back by the ice. Ross made a similar attempt on his second voyage, and actually crossed the antarctic circle in longitude 156° 28′ W., or fourteen hundred miles to the eastward of the place where he crossed it on his first voyage; but he was afterwards driven to the west by the pack, and reached his lowest latitude in 161° 27′ W. There is next the gap between Louis Philippe Land and Enderby Land. This has been tried by various navigators. The most successful was Weddell, who, in 1823, got as low down as 74° 15′ S. on the 35th meridian (W.), and found there a sea clear of ice. Weddell accomplished this great feat in a brig of 160 tons burthen, accompanied by a cutter of 65 tons. He would have sailed still further south but for the lateness of the season, which rendered it prudent to turn back. D'Urville, however, following on his track, could not attain to even

66°; and Ross, on the same meridian, was stopped by an impenetrable pack at 65° 13′ S. Ross afterwards sailed eastward, and reached the latitude of 71° 30′ S. in 14° 51′ W. Still further eastward, on the second meridian west longitude, Bellingshausen reached 69° 45′ S. None of these navigators met with land at the extreme limits of their voyages. Finally, it is necessary to ascertain whether a connection exists between Victoria Land and Terre Adélie.

The practical object which I have in view is to urge that, as soon as circumstances permit, an expedition should be fitted out at the joint expense of the Australian and New Zealand governments for the purpose of following up Ross's discoveries, and ascertaining whether land does or does not exist between Victoria and Alexander Land. Such an enterprise would doubtless be outside the routine work of these governments; but is nevertheless one to which they might properly devote their attention, unless, indeed, we accept the theory that Englishmen who happen to reside in a colony thereby become emancipated from national duties, and are entitled to consecrate their lives to money-making. The cost would be considerable, but when we reflect how many expeditions, which have made important discoveries in the Arctic Seas, have been despatched from England, the United States, and Germany, at the expense of private persons, it seems absurd to contend that it would be beyond the means of these rich Colonial Governments. What is wanted are two auxiliary steamers, of from 300 to 400 tons burthen, officered and manned from the Royal Navy, and provisioned for three years, so that if a harbour could be found the ships might be able to winter in the Antarctic Seas. The natural starting point of such an expedition would be Port Chalmers. The expedition would sail about the middle of November, and would be able to continue its explorations until the end of February, when it must either look for winter quarters or return home.

It is possible that the vessels might not be able to winter in the ice, for one of the peculiar difficulties connected with antarctic explorations is that no harbour has yet been found where vessels can go into winter quarters as they are accustomed to do in the arctic regions. Hence Ross, on each of his three voyages, was only able to remain in the Antarctic Seas during the summer season, and could not therefore utilise the winter for land expeditions. He was also compelled to navigate in sailing ships, and without any of the appliances for securing the health of the crews and the safety of the vessels, which have since almost raised Polar exploration to the rank of an exact science. Nevertheless, his discoveries were of a remarkable character, and in reading his narrative one can easily perceive

how much more he would probably have done had he been aided by steam. On his second voyage, when he attained the highest latitude ever reached, he was 56 days in the pack, which was 1000 miles through, and by the time he had got out of it and reached the ice barrier it was time to return. With steamers he would probably have pierced the pack in two or three weeks. In the event of the expedition being unable to winter in the ice, I should propose that the explorations be renewed in the next and following years, thus making three attempts to accomplish the objects in view.

It cannot, however, be denied that the antarctic explorer has a harder task to encounter than his northern comrade. The cold is more intense; storms more frequent; while a constant heavy swell of the sea adds to the dangers of the navigator. Describing the state of the ice barrier on February 9, 1841, Ross says, "gigantic icicles depended from every projecting point of its perpendicular cliffs, proving that it sometimes thaws, which otherwise we could not have believed, for at a season of the year equivalent to August in England we have the thermometer at 12°, and at noon not rising above 14°; this severity of temperature is remarkable, also, when compared with our former experience in the Northern Seas, where, from every iceberg you meet with, streams of water are constantly pouring off during the summer." There is not the smallest trace of vegetation visible in these inhospitable regions, even in the middle of summer. The most southerly spot where vegetation has been seen is Cockburn Island, one of the South Shetland Group, situated in latitude 64° 12′ S.; but it only consists of a few mosses, algæ and lichens. No land animals have been observed. Whales, seals, penguins, petrels, and skua gulls are the only visible living creatures in the highest latitudes that have been reached. The winter is rather longer and the summer shorter than in the Arctic Seas. These peculiarities would of course prove great hindrances to land explorations, which would, even if they could be undertaken at all, have to be made under different and more arduous conditions than those attaching to land journeys in the North Polar regions.

The determination of the existence, or non-existence, of an Antarctic Continent is the principal problem to be solved by a South Polar expedition. It must, however, be also borne in mind that the geographical discoveries which have already been made are of the baldest nature. Certain lands are known to exist and that is all. They have never been explored. Louis Philippe Land and the other land to the south of Cape Horn are the only Antarctic Lands of whose geography and productions we have any real knowledge, and that is very limited. But the explorer's foot has never trodden Victoria Land, Terre Adélie, Sabrina, or Enderby

Land. Outlying islands alone have been visited, and then for the briefest period. The main land has been seen from a distance bursting through the antarctic ice-cap and that is all. It is of the utmost interest to know whether all or any of these lands are inhabited by human beings. Their entire separation from the great continents of Asia and America, and the want of even the limited means of subsistence afforded by the North Polar regions for mankind, seem to forbid the supposition but are not conclusive, and nothing but actual research can settle the question.

A knowledge of the geology of those regions would be of deep interest, but it is noticeable that, according to such observations as could be made, the lands visited by Ross's expedition were wholly volcanic in character. There was an entire absence of sedimentary formations, whose examination in the North Polar regions has yielded such useful fruits to science. Even in zoology a new expedition could hardly be barren of results, for Ross's enriched the naturalist's catalogue considerably. Ice action, too, is playing such an important part in modern geological speculations, that it is a little surprising that such a novel field of study as the Antarctic regions has not been taken up before, inasmuch as ice here assumes highly characteristic forms, quite different from those it presents in the north. Meteorological and magnetic phenomena can also be studied under peculiar advantages. The precise object of Ross's expedition was to take magnetic observations, and to reach the south magnetic pole. Ross determined the position of the latter, but did not get within 160 miles of it. I could, however, traverse a large part of the domain of physical research, pointing out how it would be enriched by an antarctic expedition, but I have said enough to prove that such an expedition would be likely to produce scientific fruits of the utmost value. Its probable commercial results must also not be overlooked. Ross discovered plentifully-stocked whaling grounds, and a rich bed of guano on Possession Island, situated in lat. 71° 56′ S., and long. 171° 7′ E. Upon this island there were scaly penguins in myriads, and the same bird was seen in immense numbers in other places. This species of penguin attains a large size, the birds often weighing as much as 60lbs. or 70lbs. a-piece, and, as they yield a valuable medicinal oil in considerable quantity, their capture ought to be commercially profitable. Seals, too, swarm in the lower latitudes, where they have bred undisturbed during countless ages. Indeed, when we begin to contemplate the vast impetus which might be given to the commerce of New Zealand and the neighbouring colonies by a thorough exploration of the Antarctic Seas, the imagination is apt to wander into boundless regions of potential wealth, only awaiting the enter-

prise of man to become available for his use. I shall not, however, be tempted into this attractive ground, but shall content myself with pointing to its allurements.

I have not entered upon the details of the proposed expedition, because they can be better discussed in a separate paper. My present aim is to direct your attention to an important but neglected subject in which New Zealand is specially concerned. This colony has contributed nothing to the cause of geographical discovery. Australia has done much, and the adventurous feats of travel which have been performed by Eyre, Sturt, Stuart, Leichardt, Burke, and other explorers, are such as to justify the belief that their names will be perpetually preserved, not only in local but in the national memory. It is deeds like these which redeem the colonies from the reproach of being engrossed in the selfish pursuit of wealth; and it is by these means alone that we shall become entitled to rank in the eye of the future historian with our fellow-countrymen in the older parts of the empire. We pride ourselves much upon our industrial successes; upon the vastness of our flocks and herds; upon the immense crops of grain we raise; upon our budding manufactures; the roads, railways, and bridges we have built; and all the other manifestations of our material progress; but these things are for ourselves alone, and can claim no higher praise than appertains to a man who devotes his life solely and successfully to the acquisition of a private fortune. We have as yet done nothing for mankind, nothing for the intellectual advancement of our race; we have laid upon our backs none of those mighty but glorious burdens which fall to the lot of those who occupy the lofty station of citizens of an ancient and illustrious State.

The physical characteristics of New Zealand have virtually shut its settlers out from the field of geographical exploration, so far as the country itself is concerned; but, on the other hand, it is the most convenient base for operations in the noble arena of research which lies open for our enterprise in the South Polar Seas. No real obstacle stands in the way. Experienced officers and men could be got in plenty from the Royal Navy. The Home Government would no doubt willingly lend their services, and the arctic service is so popular in the navy that we should only have to pick and choose from amongst the volunteers. I propose that the vessels should be manned from the Royal Navy, because it was admitted by all competent authorities on the subject that naval discipline tends materially to the success of polar exploring expeditions, and is a sure safeguard against such misfortunes as those which befel Captain Hall's expedition in the 'Polaris.' The scientific staff, however, should consist exclusively of

colonists. They would, of course, be easily obtainable. The question of money is the real one, but the difficulty there lies not in our want of funds, but in the unwillingness of the Assembly to vote money for any purpose which is not likely to prove of immediate practical utility. The cost, however, when divided between several colonies would fall lightly enough upon each, and I cannot bring myself to believe that either the colonists of New Zealand as a body, or their representatives in the General Assembly, would begrudge the expenditure of £15,000 or £20,000 (for our share would probably not exceed that sum) upon a scientific work which would shed lasting honour upon the colony.

Art. III.—*On the Cleansing of Towns.* By J. Turnbull Thomson, C.E., F.R.G.S., F.R.S.S.A., Surveyor-General of New Zealand.

[*Read before the Wellington Philosophical Society, 30th November*, 1878.]

An efficient and economical system of town cleansing is a responsibility that soon forces itself on colonial communities; hence its discussion cannot but be fraught with interest. Even in mere camps the subject is of the first importance to the health of armies, to travellers, or to moving tribes and peoples; an early appreciation of which we have in the laws of Moses.*

That it is not otherwise in New Zealand is evidenced by the various enquiries that have been instituted from time to time, by the measures of the various town councils, and by the reports and papers of engineers. The earliest Sanitary Commission in New Zealand, that I am aware of, was that of Dunedin, in which city it is stated that the death-rate, in the year 1863-4, was 35·3 per thousand. More recent statistics show great variation in different towns and years, as follows:—

Auckland ..	in 1875 ..	35·77	in 1877 ..	16·68 per 1,000
Wellington ..	" ..	26·01	" ..	19·50 "
Nelson ..	" ..	27·39	" ..	16·96 "
Christchurch	" ..	30·44	" ..	15·50 "
Dunedin ..	" ..	22·24	" ..	13·87 "

Impressed with the weight of the above considerations, during my recent visit to England I took the opportunity of examining the actual state of the sanitary works in several towns either wholly or partially, besides which I obtained personal interviews with the officers of several of the Boards, thus directly obtaining the views that had been arrived at by a full knowledge of

* Deut. xxiii., 12, 13.

their local circumstances and wants. These I found, as will be seen in the sequel, to be very various and often discordant.

First of importance was the drainage of London, and to this I had free access given me by the officers of the Metropolitan Board of Works, whereby I was enabled to inspect the arterial, side, and house-drains, as well as the outfalls some miles below the city. I had also several papers given me describing the same, and to these I shall now refer, quoting first in order from a paper by their engineer.* Here we are informed that the "subject of sewerage received the attention of the Legislature at an early date;" and that "amongst others, a proposal by Sir Christopher Wren for improved drainage, nearly two hundred years ago, is preserved in MS. in the records of the ancient Westminster Commission."

Again: "Up to about the year 1815 it was penal to discharge sewage or other offensive matters into the sewers. Cesspools were regarded as the proper receptacles for house drainage, and sewers as the legitimate channels for carrying off surface waters only; afterwards it became permissive, and in the year 1847 the first Act was obtained making it compulsory to drain houses into the streets."

Again: "Prior to the year 1847 sewers were under the management of eight distinct Commissions," who "carried out (each) its drainage works, frequently regardless of the effect thereby produced upon the neighbouring districts through which the sewage flowed."

Again: "In the year 1847 these eight Commissions of Sewers were superseded by one Commission termed 'the Metropolitan Commission of Sewers,'' who made "the adoption of the new system of drainage compulsory, so that, within a period of six years, thirty thousand cesspools were abolished, and all the house and street refuse was turned into the river."

Again: "Similar systems were, about this period, to a large extent adopted in the provincial towns, by which means their drainage has been vastly improved, but the rivers and streams of the country have become very generally and seriously polluted."

Again: "In 1852 the fifth Commission was issued, (when) fresh plans for intercepting the sewage of the metropolis still continued to be heard before the Commission, and were from time to time examined and reported on without any practical result. In 1854 the author (Sir J. W. Bazalgette) was directed to prepare a scheme of intercepting sewers intended to effect the improved drainage of London."

Again: "The sixth Commission, formed in 1855, continued to discuss the subject, but without coming to a practical result." "But it was not alone the anomalies of the old Commissions, &c., which compelled the

* "Main Drainage of London," by Sir J. W. Bazalgette, M. Inst. C.E.

adoption of a general system of main drainage. The metropolis had suffered severely in the cholera visitation of 1831–2, again in 1848–9, and lastly in 1853–4." "The places formerly most favourable to the spread of the disease became quite free from it when afterwards properly drained."

Again: "In designing a system of main drainage these points had to be kept in view—to provide ample means for the discharge of the large and increasing water supply consequent on the universal adoption of water-closets, and of the ordinary rainfall and surface drainage at all times, except during extraordinary storms, and to afford to the low-lying districts a sufficiently deep outfall to allow of every house being effectually relieved of its fluid refuse."

Again: "For centuries there had existed Sewers Commissions appointed by the Government, and irresponsible to the ratepayers, upon whom they levied rates." "The author (Sir J. W. Bazalgette) having been appointed engineer to the Metropolitan Board was again instructed to prepare a plan for the drainage of the metropolis;" "and it was through the influence of Lord John Manners that the Board was left free to carry out their system of main drainage."

Again: "The objects sought to be attained in the execution of the main drainage works were—the interception of the sewage (as far as practicable by gravitation), together with so much of the rainfall mixed with it as could be reasonably dealt with, so as to divert it from the river at London; the substitution of a constant, instead of an intermittent flow in the sewers; the abolition of stagnant and tide-locked sewers, with their consequent accumulations of deposit; and the provision of deep and improved outfalls for the extension of the sewage into districts previously, for want of such outfalls, imperfectly drained."

Again: "According to the system it was sought to improve; the London main sewers fell into the Thames, and, most of them passing under the low grounds in the margin of the river before they reached it, discharged their contents into that river at or about the level, and at the time of low water only. As the tide rose it closed the outlets and ponded back the sewage flowing from the high ground."

"The volume of pure water in the river (Thames) being at that time at its minimum rendered it quite incapable of diluting and disinfecting such vast masses of sewage."

Again: "In the system now adopted it has been sought to remove those evils by the construction of new lines of sewers laid at right angles to those existing, and a little below their levels, so as to intercept their contents and convey them to an outfall fourteen miles below London Bridge."

"By this arrangement the sewage is not only at once diluted by the large volume of water in the Thames at high-water, but is also carried by the ebb tide to a point in the river twenty-six miles below London Bridge, and its return by the following flood tide within the metropolitan area is effectually prevented."

Again: "At the threshold of my (Sir J. W. Bazalgette's) enquiry into this subject the following important points required to be solved:—

"1st. At what point and state of the tide can the sewage be discharged into the river, so as not to return within the more densely inhabited portions of the metropolis?

"2nd. What is the minimum fall which should be given to the intercepting sewers?

"3rd. What is the quantity of sewage to be intercepted, and does it pass off in a uniform flow at all hours of the day and night, and in what manner?

"4th. Is the rainfall to be mixed with the sewage? In what manner and quantities does it flow into the sewers; and, also, is it to be carried off in the intercepting sewers, and how is it to be provided for?

"5th. Having referred to all these points, how are the sizes of the intercepting and main drainage sewers to be determined?

"6th. What description of pumping engines and of pumps are best adapted for lifting the sewage of London at the pumping stations? So comprehensive a subject, involving not only the above but many other important topics, cannot be fully considered within the limits of an ordinary paper, in which these questions can only be briefly touched upon."

Experiments by floats were now made on the river Thames, by which it was found that "the excess of the ebbs over the floods was only five miles in four days," and "that a substance in suspension, works up the river about one mile a day at each high water, as the springs strengthen, and down the river two miles a day as they fall off." Again: that "the delivery of the sewage at high water into the river at any point, is equivalent to its discharge at low water at a point twelve miles lower down the river; therefore the construction of twelve miles of sewer is saved by discharging the sewage at high instead of at low water."

The flow of sewage in the drains was then determined by reference to the data afforded by the works of well-known authorities, and it was concluded by the engineer to regard that "a mean velocity of one-and-a-half miles per hour in a properly protected main sewer, when running half full, is sufficient, more especially when the contents have passed through a pumping station."

In estimating the quantity of sewage to be carried off "provision has been made for an increase of the population up to 30,000 people to the square mile, except over the outlying districts, where provision has been made for a population giving 20,000 to the square mile." "An improved water supply, equal to five cubic feet, or 31¼ gallons per head for such contemplated increased population has moreover been anticipated."

Again: "How to dispose of the rainfall is a question of considerable difficulty, and has given rise to much diversity of opinion. This arises from the fact that, whilst it is in itself harmless, and even advantageous to the river, it sometimes falls suddenly in large quantities. These considerations have induced theorists to advocate that the rainfall should not be allowed to flow off with the sewage, but should be dealt with by a separate system of sewers. This theory however is most impracticable."

Referring to experiments on this subject the result "distinctly establishes the fact, that the quantity of rain which flowed off by the sewers was, in all cases, much less than the quantity which fell on the ground," also "that ¼ of an inch of rainfall will not contribute ⅛ of an inch to the sewers; nor a fall of $\frac{4}{10}$ of an inch more than ¼ of an inch."

Again: "As it would not have been wise or practicable to have increased the sizes of the intercepting sewers much beyond their present dimensions in order to carry off the rare and excessive thunderstorms, overflow sewers, to act as safety valves in times of storms, have been constructed at the junctions of the intercepting sewers with the main valley lines."

Again: "Having determined the quantities of sewage and rainfall to be carried off, and the rate of declivity of the sewer required for the necessary velocity of flow, the sizes of the intercepting sewers were readily determined by the formulæ of Prony, Eytelwein, and Du Buat."

Again: "A primary object sought to be attained in this scheme was the removing as much of the sewage as practicable by gravitation, so as to reduce the amount of pumping to a minimum." Under this view, on the north side of the Thames, the high level sewer commences at the foot of Hampstead Hill, passing through certain districts of London, draining about ten square miles (shown in the plan), the form of which "is mostly circular, and it varies in size from 4 feet in diameter to 9 feet 6 inches by 12 feet; its fall is rapid, ranging at the upper end from 1 in 71 to 1 in 376, and from 4 feet to 5 feet per mile at the lower end."

The middle level sewer is as near the Thames as the contour of the ground will allow, the area intercepted being 17½ square miles.

The low level sewer intercepts the sewage from the low level area, which contains 11 square miles. "It is also the main outlet for a district of about

14½ square miles, forming the western suburb of London, which is so low that its sewage has to be lifted at Chelsea a height of 17½ feet into the upper end of the low level sewer. It is tunnelled under the river Lea, on its route to Abbey Mills, where its contents are raised 36 feet by steam power.

Again: "The northern outfall sewer is a work of peculiar construction; as, unlike ordinary sewers, it is raised above the level of the surrounding neighbourhood in an embankment, which has the appearance of a railway embankment, and it is carried by aqueducts over rivers, railways, streets and roads."

Again: "The Barking reservoir is 16¾ feet in average depth, and is divided by partition walls into four compartments, covering altogether an effective area of 412,384 superficial feet, or about 9½ acres. The external and partition walls are of brickwork, and the centre area is covered by brick arches supported upon brick piers, the floor being paved throughout with York stone. The reservoir, being almost entirely above the general surface of the ground, is covered by an embankment of earth, rising about 2 feet above the crown of the arches. The ground over which it is built being unfit to sustain the structure, the foundations of the piers, and of the walls, were carried down in concrete to a depth of nearly 20 feet."

Again: "The Abbey Mills Pumping Station will be the largest establishment of the kind in the main drainage works, providing, as it does, engine-power to the extent of 1140 h.p. for the purpose of lifting a minimum quantity of sewage and rainfall of 15,000 cubic feet per minute a height of 36 feet."

The Engineer adds that "It is fortunate that these works were not projected in the year 1306 when coal was first introduced into London, and was regarded as such a nuisance that the resident nobility obtained a royal proclamation to prohibit its use under severe penalties; for this pumping station alone will consume about 9700 tons of coal per annum. The cost of pumping is not, however, actually in excess of the former expenditure upon drainage, for the cost of removing deposit from the tide-locked and stagnated sewers in London, formerly amounted to a sum of about £30,000 per annum, and the substitution of a constant flow through sewers by means of pumping must necessarily reduce the deposit, and consequently the annual cost of cleaning."

Again: "On the south side of the Thames the high-level sewer and its southern branch correspond with the high and middle-level sewers on the north side of the Thames." "Both lines are constructed of sufficient capacity to carry off the flood waters, so that they may be entirely inter-

cepted from the low and thickly inhabited district, which is tide-locked and subject to floods. The storm-waters will be discharged into Deptford Creek, whilst the sewage and a limited quantity of rain will flow by four iron pipes laid under its bed, each 3 feet 6 inches in diameter, into the outfall sewer."*

Again: "The main line varies in size from 4 feet 6 inches by 3 feet at the upper end to 10 feet 6 inches, of the same form as the branch by the side of which it is constructed."

Again: "The falls of the main line are at the upper end 53 feet, 26 feet, and 9 feet per mile to the Effra sewer at the Brixton Road, and thence to the outlet, 2½ feet per mile. The sewer is erected in brickwork, varying in thickness from 9 inches to 22½ inches, that forming the invert being in Portland cement, and the remainder in blue lias mortar."

Again: "The low-level sewer does not follow the course of the river as on the north side; but commencing at Putney it takes a more direct line through the low ground once forming the bed of the second channel of the Thames, and drains Putney, Battersea, Nine Elms, Lambeth, Newington, Southwark, Bermondsey, Rotherhithe, and Deptford." The Engineer adds that this district being mostly level was formerly much subject to be overflown, and to stagnation of waters, causing malaria, so much so that "the late Mr. R. Stephenson and Sir W. Cubitt forcibly described the effect of artificial draining by pumping as equivalent to raising the surface to the height of 20 feet. The low-level sewer has in fact rendered this district as dry and as healthy as any portion of the metropolis."

Again: "The Deptford pumping station is situated by the side of the Deptford Creek, and close to the Greenwich railway station. The sewage here is lifted from the low-level sewer to a height of 18 feet into the outfall sewer. Four expansive condensing rotative beam engines, each of 125 h.p., and capable together of lifting 10,000 cubic feet of sewage per minute to a height of 18 feet, are here constructed."

Relating to the southern outfall sewer: "The large volume of water met with in the marshes rendered the construction of that portion of the work very costly. These marshes originally formed part of the Thames, and were first enclosed, in the reign of Edward I., by the monks of Lesnes Abbey. Two thousand acres were afterwards flooded by the bursting of the river banks in the reign of Henry VIII., and were not again reclaimed until the reign of James I."

Again: "The outfall of the sewage at the south side of the Thames is at Crossness reservoir and pumping station. The sewage is discharged into the river at the time of high water only; but the sewer is at such a level

* Written in 1865.

that it can discharge its full volume by gravitation about the time of low water."

Again: "The maximum quantity of sewage to be lifted by the engines (at Crossness), will ordinarily be 10,000 cubic feet per minute, but during the night that quantity will be considerably reduced—while, on the other hand, it will be nearly doubled on occasions of heavy rainfall. The lift will also vary from 10 to 30 feet, according to the level of the water in the sewer and in the reservoir into which it is lifted." "The reservoir, which is 6½ acres in extent, is covered by brick arches, supported on brick piers, and is furnished with weirs for overflows with a flushing culvert."

Again: "The specifications provide that the whole of the cement shall be Portland cement of the very best quality, ground extremely fine, weighing not less than 100lbs. to the bushel, capable of maintaining a breaking weight of 500lbs. to the bushel on 1½ square inch, seven days after being made in an iron mould, and immersed in water during the intervening seven days."

Again: "The total cost of the main drainage works when completed will have been about £4,100,000." "The sum for defraying the cost of these works is raised by loan, and paid off by a 3d. rate levied in the metropolis, which produces £180,262 per annum, the rateable value being £14,421,011, and the principal and interest of the loan will be paid off in forty years."

"There are about 1,300 miles of sewers in London, and 82 miles of main intercepting sewers. 380,000,000 of bricks and 880,000 cubic yards of concrete have been consumed, and 3½ million cubic yards of earth have been excavated in the execution of the main drainage works. The total pumping power employed is 2,380 nominal h.p.; and if at full work night and day 44,000 tons of coals per annum would be consumed, but the average consumption is estimated at 20,000 tons."

"The sewage of the north side of the Thames at present amounts to 10 million cubic feet per day, and on the south side to 4 million cubic feet per day; but provision is made for an anticipated increase up to 11¼ millions on the north side, and 5¾ millions on the south side, in addition to 28½ million cubic feet of rainfall per diem on the north side, and 17½ million cubic feet per diem on the south side; or a total of 63 million cubic feet per diem, which is equal to a lake of 482 acres 3 feet deep, or fifteen times as large as the Serpentine in Hyde Park."

Turning now to the labours of a deputation appointed by the Town Council and Board of Police of the city of Glasgow, to enquire into the methods of disposing of sewage adopted in various towns in England*,

* Report dated October, 1877.

we find it stated in the appendix of their Report that—

Leeds has a population of 291,580, covering an area of 21,572 acres. But the town at present sewered covers only about 4,900 acres, with a population of 245,600, thus showing a population of 50 to the acre, while Glasgow has 88·6. The average mortality for the five years—1871 to 1875 inclusive—is 27·4 per 1,000. The number of water-closets in Leeds is 8,500, and of ash-pits and privies 13,000, and about 3,000 of the latter are provided with pails or boxes. Many of the privies have been recently altered into trough water-closets, which are highly approved by Dr. Goldie, the Medical Officer of Health. Originally experimental works were erected to test the efficacy of the A, B, C process, which was in the hands of a Native Guano Company. These works cost about £10,000, and were constructed to treat 2 million gallons of sewage daily. The success of the experiment, so far as producing an apparently good effluent, induced the Corporation to erect works for the chemical treatment of the entire sewage of the town, amounting to nearly 14 million gallons daily, which cost £50,000; but since the works have been in operation practically, it has been found impossible to dispose of the produce in any quantity. As regards undried sludge the farmers in the vicinity refuse to accept it as a gift.

Bradford has a population of 173,000 and covers an area of 7,221 acres, giving a density of population equal to 24 per acre. The average death-rate is 26·1 per 1,000. The number of water-closets is about 2,000, and of dry-closets 3,000. The works for the purification of the sewage are at Manningham, about 1¼ miles from the town. The sewage amounts on an average to 9 million gallons per day, and the precipitant used is lime. The quantity employed is about 18 cwt. per million gallons of sewage. The works cost £65,000, and cost of working £5,000 per annum.

Halifax, a town of 68,500 inhabitants, occupies an area of 3,768 acres, giving a density of population equal to 18 per acre. The average mortality is 26·6 per 1,000. The town contains 2,000 water-closets and about 3,300 dry-closets. The sewage amounts to 2½ millions of gallons (per diem), and is carried in a culvert to a small *beck* or *burn*, which runs through the valley in which the town is situated. Formerly lime was used to defecate the sewage, but this attempt at purification has ceased. The Goux system is here adopted for the dry-closets. Once worked by a company, but at a heavy loss, the Corporation now carry on the works.

Croydon has a population of 63,000, and occupies a space of 10,000 acres, giving a density of population equal to 6·3 per acre—the average annual mortality being 19 per 1,000. The sewage in dry weather amounts

to 2½ millions of gallons per diem, and the number of water-closets is about 15,000. The whole sewage is disposed of by irrigation, for which the place is eminently adapted by nature. Crops of rye grass are thus obtained in value £40 per acre. Financially the farm to which the sewage is applied is not a success, the loss per annum varying from £1,012 to £1,700. The Deputation say it is, however, probably the most successful sewage farm in England.

Of LONDON the Deputation remark that the population is 3,500,000; the density per acre being 45·7, and mortality 22·9 (per 1,000). Here also the sewage farms have been unsuccessful, and I need not go over the ground already traversed in the preceding part of this paper.

BIRMINGHAM has a population of 375,000, occupying an area of 8,420 acres; density, 44·5 persons to the acre; death-rate, 25·2 per 1,000. The number of water-closets in 1872 was 7,065, but though the population has largely increased since that time, the number of water-closets is now only 7,514. In fact, the use of these is discouraged by the municipal authorities, although not absolutely forbidden. The number of houses in 1871 was 75,000, and since that time 8,420 have been erected, bringing up the present number to 83,420. The number of pan-closets in use in 1876 was 17,000, all the new houses of the smaller class being fitted with these—one closet serving for not more than two houses. Of ordinary privies, at the same date, there were 27,436, and of ash-pits 19,154. The quantity of sewage is from 12 million to 16 million gallons per day, and before being passed into the River Tame it is treated with lime to cause precipitation. The sludge is also treated by a patented process, the annual expense of which, after deducting income from revenue, is £12,000.

The Rochdale system of pails for night-soil, and tubs for ashes is carried out at Birmingham; about 17,000 pans being now in use.

COVENTRY has a population of 40,000; an average annual mortality of 23·4 per 1,000, and 10 persons to the acre. The water supply is from artesian wells. The present number of water-closets is about 5,000; and privies, 800. The sewage works are about a mile from the town, and the effluent goes into a small stream called the Sherbourne. The sewage is passed through gravel filters before it is let out in the stream. But the system becoming inefficient, works for purification and utilisation were erected at a cost of £14,000. But the company to whom the sewage was conceded had to succumb. The Corporation now carries on the works at a yearly expenditure of about £2700.

MANCHESTER has a population of 356,000; the average death-rate being 30 per 1000. The number of persons to the acre is 83. The river Irwell

separates it from Salford, which has a population of 136,000, and whose death-rate is 29·3 per 1,000, and density per acre, 26·3. There are comparatively few *water-closets* in Manchester, and they are discouraged as much as possible, and practically forbidden in houses of a smaller kind. There are 42,000 privies, and these are gradually being altered into pan-closets. Already 24,000 have been thus converted; and Dr. Leigh, the medical officer of health, expects that in three years the whole will have been altered. Dr. Leigh calculates that, when all the privies are converted, 6 million gallons of urine annually will be kept out of the sewers, and consequently out of the Irwell, that were formerly allowed to flow into it. Next, the system of removing is entered into, but we pass over this, and only note that about 3,000 tons of material are dealt with weekly, and these consist of—paper, 1 ton; rags, 3 tons; dead animals, 2 tons; stable manure, 2 tons; old iron and tin plate, 33 tons; refuse from slaughter-houses and fish shops, 60 tons; broken pottery, earthenware and glass, 80 tons; vegetable refuse, door-mats, table-covers, floor-cloths, old straw mattrasses and 100 tons fine ashes, 1,230 tons; cinders, 1,400 tons. These are separated, and specially dealt with; and, I may note here that, amongst these, 400 tons of manure is made weekly, and sold at 12s. 6d. per ton.

Oldham was the last place visited by the Deputation. It is a purely manufacturing town, having a population of 88,000, and an annual mortality of 28·2 per 1,000; the density, per acre, being 18·7. The pail system is in general use, and the contents are taken by the Carbon Fertilizing Company, who have purchased the patent for absorbing excrementitious matter by charcoal. The Deputation add that, unfortunately, this patent does not appear to have had a fair trial, the works being in inextricable confusion.

Glasgow.—A few statistics of their own city is added, of which the following, as well as the preceding, are extracts. The estimated population in 1875 was 534,564, and the average mortality 29·9. The area of ground occupied is 6,034 acres; giving an average density of 88·6 persons per acre. The number of dwelling-houses in 1874 was 101,368; and of shops, warehouses, and factories, 16,218. The water-closets numbered 31,927; sinks, 71,291; fixed basins, 3,865; and urinals, 211. There are, also, at the present date (1878), 6,751 dry ashpits; 1,395 middins or wet ashpits; 3,816 pan-closets; 94 trough-closets (chiefly in public works); and 13 public conveniences, 7 of which are fitted with pans, and 6 with Macfarlane's patent troughs. One hundred and nine manufactories discharge refuse of various kinds into the sewers. And there are 2,304 stables, with 7,024 horses;

and 311 cow-houses, with 1,350 cows. In addition to the factories, the refuse is conveyed into the drains. Twenty discharge direct into the river. The length of the sewers is about 100 miles. Within the city boundary there are at present 131¼ miles of paved streets, 20½ miles of statute labour roads, and 10 miles of turnpike roads; in all 162 miles.

The estimated volume of discharge into the river daily is 40 millions of gallons, exclusive of rainfall, but including the water of the Molindinar and other *burns*. The total quantity of sewage in wet weather would be about 74 million gallons per day. The water sent into the city and suburban villages (from the waterworks) averages 33 millions of gallons per day. It is distributed to a population of 710,000, so that the volume of water per head was 46½ gallons a day.

From the conclusions arrived at, as set forth in the report of the Deputation, we make the following extracts: The question of conservancy of rivers was constantly pressed on their attention, many of the inland towns being compelled, under heavy penalties, to render their sewage clear, inodorous, and perfectly colourless, and sometimes under manifest injustice. The necessity of a Conservancy Board to watch over the whole drainage area of the various river-basins was constantly dwelt upon by the various authorities, as the only means of solving the important questions which were so intimately connected—the disposal of sewage, and the restoration of rivers to a state of purity. The Deputation state *as a fact* that the sewage question, in London even, *is only partially solved*; and in reference to the immediate subject of their attention, viz., Glasgow, the Deputation are of opinion that no sewage works can safely be undertaken till a Conservancy Board has been constituted for the Clyde. They point out at the same time that this city, in respect to area for discharge, is fortunately placed, being into a *tidal river*, as contra-distinguished from many of the inland cities of England, whose outfalls are into sluggish rivers of small capacity.

They point out that it has never yet been shown that the foul condition of the Clyde is directly injurious to health; and of the mode of dealing with sewage in particular, there are two ways, viz., the dry system, and carriage by water; the first being the most rational as well as consistent with public health and with national prosperity, which, however, has weak points, that while it disposes of excreta, it leaves untouched all other sewage which would still require to be removed by water-carriage, and be purified of course before passing into a river in the same way as if it had contained the whole excreta. While, therefore, they hold that upon economical and sanitary grounds, water-closets in houses—especially in houses of the smaller sort—and in public works, gaols, railway stations, &c., should, as far as possible, be

replaced by an efficient dry system, they do not think that the adoption of this course will very much lessen the amount of sewage to be dealt with, or render its purification less imperative.

When water-carriage is used, the following methods may be employed:—

1st. Running into the sea or into a tidal river, under conditions that will prevent its return.

2nd. Irrigation.

3rd. Intermittent filtration.

4th. Purification by precipitation—

(*a*) by lime.

(*b*) by sulphate of alumina.

(*c*) by the A, B, C system.

The dry method includes—

1st. Pan closets.

2nd. Earth closets.

3rd. Goux system.

4th. Stanford's system (Carbon Fertilizing Company).

5th. Lienur's pneumatic system.

In regard to Glasgow, the report notices Messrs. Bateman and Bazalgette's scheme to pump the sewage to a high level and then carry it down to the Ayrshire coast. The plan adopted in London of running the unpurified sewage into the river could not be supported owing to the small current of the Clyde tidal waters.

If the sewage of Glasgow were taken to Farland Point, or to the lands between Irvine or Saltcoats, the scheme would resemble that carried out by Sir J. Hawkshaw for Brighton, whose outfall sewer is about eight miles long; but efficient ventilation would require to be applied to carry off the noxious gases generated.

Of dealing with sewage by irrigation, great hopes were entertained a few years ago that the grand solution had been attained. All this is now changed, owing to general failure. Probably the Beddington Manor Estate at Croydon is the most successful of sewage farms, and the report states that it is no small matter to say that it disposes of the sewage of a population of 60,000 persons at an outlay which is now reduced to a little over £1,000 per annum. But the situation of Croydon adapts it in a peculiar degree to the utilization of its sewage by filtration through land. When the Deputation visited this and other sewage farms the weather was cold, so that no odours of a truly offensive nature were observed; but this is not always so; on the contrary, evidence is adduced to the effect that warm weather makes these exceedingly unhealthy, giving off a most odious stench.

It is right to add, the report continues, that at Edinburgh, Croydon and other places, no evil effects to health have been traced to the influence of the farms irrigated by their sewage; but as to the land itself, sometimes enormous quantities of sewage are applied in season and out of season, till the surfeited land *is sick*, and even then it has to take more. If the land were obtainable at an ordinary agricultural value, suitable for the reception and distribution of sewage without pumping, a sewage farm might be made to yield a profit.

Regarding chemical treatment, the report states that purification of sewage is possible, and is carried out successfully at Bradford, Leeds, Coventry, Birmingham and other towns, but, so far as the Deputation had been able to ascertain, the sale of the so-called manure appears to have failed of accomplishment, and this is not to be wondered at, as the processes fail to consume the ammonia and potash salts, which are the most valuable part.

As a precipitant, lime appears to be most capable of universal application, especially if supplemented by some form of charcoal. The A, B, C process was examined, but with unfavourable results, and the manure obtained by this process has a very low market value; the manipulations are also attended with a most nauseous odour.

Intermittent filtration has been carried out quite successfully at Merthyr Tydvil, but the conditions there are so exceptional that there are very few places where the process could be pursued with equally satisfactory results. It appears to be in operation also at Kendal.

Referring to the defects of the water-carriage system, the report points out the decomposition and evolution of sewer-gases, calling for careful ventilation in all cases.

Water-closets should be discouraged in small houses owing to the greater likelihood of their getting out of order. Drainage from stables and byres should be absolutely prohibited, and chemical factories should be under close regulation, as, where the disinfectant is cheap, there can be no hardship to the proprietors.

Coming to the dry system as affecting Glasgow, it is stated that the number of houses is 100,000, water-closets numbering only 32,000, showing that half the population is provided with these, the other half being supplied with other conveniences in one form or another of the dry-closet. This branch has therefore occupied much of the attention of the Deputation. In Leeds the old-fashioned privies are being replaced by trough water-closets; in Manchester and Birmingham, on the other hand, water-closets are being systematically repressed, and elaborate attention is being paid to the develop-

ment of dry collection and daily removal. The Deputation strongly commend, on sanitary grounds, the tub and pail system, which opinion has already had wide effects in the City of Glasgow, where the gain in health and decency is great and unquestionable.

The Goux system was in operation at Halifax, but is not recommended on account of its want of simplicity.

The earth-closet is supported as being admirably suited for country houses of the better class, but otherwise it is too costly to work.

Lienur's pneumatic system in operation in Holland, was not inspected by the Deputation, as it had not been adopted in England. However, they advance an opinion that, *theoretically*, it is perfect, since the whole of the excreta are converted into a highly portable and valuable manure, while all risk of sewer-gases being formed is entirely obviated, and all operations being conducted *in vacuo* are entirely free from offence. They then quote from a report to the Local Government Board, to wit:—"As, however, the pneumatic only deals with a small fraction of the refuse to be removed from houses, leaving all other forms to be dealt with in the ordinary way, so Dutch town sewage must flow into the rivers and canals, as now, to pollute the water supply, or else some complicated mode of intercepting it must be provided at an additional cost to the local authorities. The pneumatic system is ingenious, but is complicated in its construction and working arrangements, and is liable to derangements which are sometimes difficult to mend. We do not know one English town in which the apparatus, if adopted, would be other than a costly toy."

The report of the Glasgow Deputation concludes with the following recommendations, viz.:—

1. That the system of having water-closets for public works, factories, gaols, workhouses, infirmaries, and railway stations, should be forbidden, so as to reduce the quantity of water-closet sewage now turned into the river (Clyde); water-closets in small houses should also be discouraged.

2. That ordinary privies and ashpits be altered to the tub and pail system, to be cleansed daily, as it has been carried out in Manchester and other important English cities and towns, and that special accommodation be provided for children.

3. That all drains, soil and waste-pipes, and all apparatus connected with water-closets, sinks and baths, and their connections, be constructed under public supervision.

4. That a complete system of ventilation of the common sewers throughout their entire length be immediately adopted.

5. That a system of ventilation of the house-drains and soil-pipes, inde-

pendent of the common sewers, be immediately adopted and enforced throughout the city.

6. That the use for domestic purposes of water from cisterns supplying water-closets be absolutely forbidden.

In the event of it being found necessary to purify the river—

7. That the whole drainage of the city be taken into main intercepting sewers, and conducted to a suitable point; and, after having been rendered clear by precipitation and filtration, passed into the Clyde.

8. That the sludge obtained in the precipitation process be got rid of in the cheapest possible manner. A part of it might be utilized in making up waste land, and a certain quantity might be taken away by farmers, but the greater part would probably require to be disposed of in the same manner as the dredgings of the rivers.

The report entirely discards the idea of utilization of the sewage itself, or the precipitate obtained by the action of lime or other chemical agents. The sludge obtained by many of the patented processes is dried at such cost, and its value when dry so trifling, that all hopes of disposing of it for manurial purposes—at a price that would be remunerative—is entirely illusory.

The report concludes that, while they consider the purification of the Clyde important, yet for the health of the city, the sewage works are of greater consequence, which they hope will be carried out without unnecessary delay.

Attached to the Glasgow report are appendices, containing the opinions of the Local Government Board, and the Health and Sewage of Towns Conference Committees, which closely coincide with the above in their recommendations, and they pointedly insist "that no one system for disposing of sewage could be adopted for universal use; that different localities require different methods to suit their special peculiarities; and also that, as a rule, no profit can be derived at present from sewage utilization, but for health's sake, without consideration of commercial profit, sewage and excreta must be got rid of at any cost."

"That the pail system, under proper regulations for early and frequent removal, is greatly superior to all privies, cesspools, ashpits, and middens and possesses manifold advantages in regard to health and cleanliness; whilst its results in economy and facility of utilization often compare favorably with those of water-carried sewage."

"That for use within the house no system has been found in practice to take the place of the water-closet."

"And that all middens, privies, and cesspools in towns should be

abolished by law, due regard in point of time being had to the condition of each locality."

By referring to appendix I.,* the cost of the several systems of town-cleansing will be seen at a glance, which will be found to vary from 1d. to 11½d. per pound on the rateable value of house property, local peculiarities evidently having influence in this matter. For instance, at Rochdale, scavengering is put down at 8¾d., Birmingham at 5¾d., and Leamington at 1d.; while sewage for Rochdale is put down at 0d., Birmingham at 4¼d., and Leamington at 5½d.; the totals being 8¾d., 10d., and 6½d. respectively. The highest rated is Blackburn, viz., at 11½d. in the pound.

Coming to my own observations, I shall first notice Berwick-upon-Tweed, as I had an opportunity of watching the construction of the waterworks and drainage of that town 23 years ago, so I inspected their state lately with more than ordinary interest. This is a town of 20,000 inhabitants, situated on rising ground near the mouth of the Tweed, and where its waters are fully affected by the tide. I ascertained that the drainage on the whole had worked well, excepting when the water-supply ran short, which occurs periodically in the summer. The sewers, constructed about 23 years ago, were well executed; but the engineer had under-estimated the water-supply, which had rendered the working somewhat experimental. The first trouble that was experienced was in the high-pressure mains being connected directly with the water-closets; this, when the supply of water was intermittent, sent the excreta back into the closets, creating great nuisances; this difficulty has now been obviated by each closet being provided with a small cistern filled by the mains, from which the closets are supplied. Before this was done, people, finding the water *not on* in leaving, tied up the valve, so that it might run when it came on, thus much of the supply was wasted by the water running continuously.

The poor classes especially are difficult to manage or to deal with, owing to the practice they are given to of abusing the conveniences, hence this class always demand sharp looking after by the inspector.

Ashpits are allowed in this town to a limited extent, but for small houses boxes or pails are used for the removal of rubbish, ashes, &c.

The sewage falls into the river Tweed, but to this the Tweed Salmon Commissioners object as it is tending to pollute the stream and destroy fish.

When the high-pressure water-supply is good and sufficient, the water-closet and sewage system of the town has worked well, but the entire problem of the removal of house-refuse has not yet been fully solved.

It is quite clear that here, as elsewhere, the subject is one for continuous effort, not possible to be settled by spasmodic exertion, and then to be done with.

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* End of Glasgow Report copied.

At the inland town of Dunse, containing about 4,000 inhabitants, and where the water-closet system has been introduced during these last 40 years, I found that, as this was perfected and in operation, new and unanticipated difficulties presented themselves. Thus, as the town became satisfactory in its sanitary condition, the rural districts near and under its level became deteriorated by the nuisances flowing on them. Which circumstance brought about long and expensive law-suits with the proprietors, and especially with the owner of Wedderburn House and Demesne.

In the town of Kelso, situated on the banks of the Tweed, and about 25 miles inland, it was observed here, also, that the increase of sewage, by the introduction of improved water supply and conveniences, was drawing opposition from the owners of the valuable salmon fishing stations. In view of this, the Corporation is now about to try and remedy the evil by carrying their outfall to an extensive shingle bank, where they hope to absorb the objectionable matters.

At Edinburgh it was observed that the sewage that used to flow solely over the fields near Holyrood House uninterruptedly, and at least, without active objections, are now not only increased in their area, but the same system of irrigation is being applied to the west suburbs of the city. Hence, no certain action by the population can be anticipated on this subject.

At Glasgow, from the report of whose Deputation I have so largely quoted, I found that still no general scheme had been decided on; in fact, that different principles had been found applicable to different parts, and broadly, the water-gravitation system to first and second-class houses, and the pail system to those inferior. The sewage yet falls into the Clyde, and Bazalgette's recommendations were considered, if not impracticable, and beyond the means of the ratepayers, at least inadvisable. As a better scheme for conveying the offal away, steam barges, proceeding from Glasgow to the sea, were contemplated; as any attempt to utilize sewage is now abandoned.

As my time and other engagements enabled me to ascertain, such is the state of town and city cleansing at home; and it will be noted that whilst much difference of opinion in detail exists amongst engineers, yet, to those who are able to bring an unprejudiced judgment to bear on the question, the principles to be adapted to the several and varied circumstances are not difficult to be laid hold of. Comprehensively speaking, the interest is a growing one, and in this respect it is not an exception from other great interests and expansions of modern civilization and requirements. If its necessities cause it to unduly infringe on other interests, then conflict

takes place, the conflict not anticipated in the early years of its application, but in the course of years becoming palpable. It is no other than the ordnance *versus* iron-plate warfare; if the one increases in force and magnitude, so the other must be fortified in ratio. Thus, if ships have to be protected from their assailants, so must the rivers, estates, parks, seats, and castles be protected from the other. Hence Corporations, in initiating sanitary improvements for themselves, are not justified, as hitherto, in neglecting the interests outside of their precincts; and, as justly observed by the Glasgow Deputation, those cities having a natural outlet apart from all other interests, are fortunate.

This latter condition is oftener the case with seabound towns than with inland ones. Certain it is that the idea so often prevailing amongst sanitary engineers that their works are for ever, and all time to come, must be abandoned, and their judgment must be exercised, not as now to create works of magnitude far beyond present wants, but to institute systems to which least objections can be taken ultimately, or for the time being. The wants of the present population must not only be estimated, and of the future, but their capacity to bear the burden of taxation, hence, though *working to an end*, and on just principles, the consideration should be as to what was actually necessary, and no more, leaving their successors to continue the same. Without being attentive to these facts, the city populations may pay too dearly for the luxury of improvements or *quasi* improvements, and property may be overburdened by works which could perfectly well be held over.

As an example of the conflict between interests, that takes place consequent on the modern introduction of town cleansing by water-gravitation, we turn to the greatest city in the world, where it has perforce had largest development. The outfall of the sewage, till recent years, was into the Thames, within the precincts of the city. This created nuisances which it was found desirable to remove; hence those measures were taken which have already been described in the preceding part of this paper. But, besides the Metropolitan Board of Works, there exists a Board of Conservators of the River Thames, having other interests than the population of London to take care of, and on which the operations of the former Board were felt to act detrimentally. In consequence of this, Captain Calver, R.N., F.R.S,, was, by the secretary, directed to investigate and report on the subject*. That gentleman acknowledged the receipt of the instructions, to wit; that he should direct his attention to some recent surveys which had been made by the officers of the Board, of that section of the River Thames extending from Woolwich to Erith, as well as to analytical examinations by

* Thames Commission, 6th June, 1877.

Drs. Letheby and Williamson of the soil of its bed, both in Woolwich Reach and near to the sewage outfalls; and to give his consideration to the changes thus shown to have taken place in the channel of the river, and in the character of its bottom, for the purpose of reporting thereon. Captain Calver adds, that from the time of receiving the foregoing instructions, he had been engaged upon the various details of investigation, including, amongst other things, repeated observations upon the movements of the streams in the central section of the Thames, with the collection of such other physical facts as were likely to aid him in arriving at a clear understanding of this important and interesting case*.

From his report we shall make extracts, noticing the salient points of interest. He states "that the general features of Mid-Thames, its sectional capacity, and the various details of increase and decrease, are all brought out very clearly in the surveys made by the order of the Board. This series—the work of the same observers, and all referable to a common standard—has been made between 1861 and 1876."

Again: "It having been reported in 1867 that a vessel had unexpectedly touched the ground while passing the southern outfall, a new survey was ordered to be made for the locality."

Again: "1832 to 1861, a considerable increase in the general capacity of the channel occurred in the foregoing period—the result of dredging, for the most part."

Again: "1863 and 1864, sewage began to be discharged from the outfalls."

Again: "Since the Metropolitan outfalls came into operation, the former deep and free frontage of the southernmost one has lost a *quarter part of its low water contents.*" Again: "that the upper part of the river has been troubled with accumulations, which, as will be shown, must *necessarily have been conveyed upwards by the flood-stream.*"

In the analyses made, "the mud in each case was black and fetid in a state of active putrefactive decomposition, and, when examined under the microscope, it was found to consist of broken-up sewage matter." Of the water, when near Woolwich, Greenwich and London Bridge, "all the samples were black and offensive, and they were found, on examination under the microscope, to consist of amorphous matter of the disintegrated tissue of vegetables, especially of wheat, and swarms of diatomaceous remains." Again: in the last test of 1875, "most of the samples demonstrated the presence of sewage matter in a state of decomposition." Those from "the Gallion Reach, within the influence of the northern outfall, exhibited organic and other similar matter to those of street-mud, while others in the

* Report, 15th October, 1877.

central track of the river-streams, and acted upon by their scourage, had very little organic matter."

Again: "The reporters of 1858 estimated that 92,000 tons of solid matter of every description were contained in the sewage passing into the Thames at that time;" but it is now estimated, from data supplied by Glasgow, that "465,000 tons would represent the annual solid matter contained in Metropolitan sewage."

Again: "The excreta of each person per day having been found by experiment to weigh 2½lbs., this, with the population of 3,500,000, in connection with the outfalls, gives 3,900 tons per day, or 1,425,000 tons per annum as the amount of excreta sent into the river from the outfalls."

Again: It was found by experiment "that matter committed to the water of Mid-Thames would move down seaward about five miles in a fortnight."

Again: "The daily discharge from the outfalls has been stated as 120 million gallons or 19,246,000 cubic feet, so that 423,412,000 cubic feet or 22 days' discharge, represents the aggregate amount of sewage in the oscillating section, being about one-fifth part of the whole contents of the river within the same limits below the level of ordinary low-water. This vast mass of polluted water—eight miles long, 750 yards wide, and 4½ feet deep, charged with offensive matter, both fluid and solid, moves up and down the channel four times daily, between Gravesend and near to Blackwall, dropping its solid burden wherever a reduction of the rate of current or still water may favour deposit. The purifying change which the putrescent matter may be supposed to undergo, after discharging from the outfalls, is reserved for future consideration."

Again: In regard to accretion of the sewage in Woolwich Reach, it is stated that there is "a complete identity between accreted matter and that in the sewage discharged from the outfalls. There can be little doubt that it has been brought from their neighbourhood by the flood-stream. Most observers of rivers are aware of the disturbing action of the first portion of the flood-set, for, owing to its greater specific gravity, it works its way upwards under the last of the ebb-set, and probably obtaining thereby a strong rotatory or grinding motion, the surface of the bottom is sufficiently disturbed to charge the water with its particles."

Again: "Another point which has bearing upon this section of the case is, the superior carrying-power of the flood-stream over the ebb; a fact very distinctly brought out in the Analytical Returns."

Again: "The amount of solid matter in the flowing-tide at Greenwich and London Bridge is nearly 21 grains per gallon, while that in the ebb-tide is only 8·2 grains."

In reference to the deleterious effect of sewage discharged into a tidal river, from various experiments, Captain Calver concludes that "it will be seen that it matters not whether the sewage be sent into the river at low-water at London, or at high-water at Barking Creek and Crossness, for the result is one and the same. The matter from the sewers will work its way upwards, and form accumulations above the outfalls both in the bed and along the sides of the channel."

Again: As to the theory which erroneously assigns deepening to the credit of sewage discharge. This is said to be due "to two very different causes—viz., to the dredging carried on in the district, and to the scour resulting from the removal of impediments out of the channel in higher portions of the river." Dredging, also, is stated to have removed "enormous hills of gravel which now disfigure and encumber the banks of the Tyne and Wear." Another cause stated as tending to increase the depth of Mid-Thames resides in the removal of the old bridge at London, and the dredging that has taken place as high up as Isleworth.

Again: "As matters now stand, the Metropolitan sewage discharge has reproduced in Mid-Thames, in an aggravated form, a nuisance which was felt to be unbearable in the upper portion of the river. Formerly, the sewers at London discharged their contents into the river at low water, and this, Sir Joseph Bazalgette has pointed out, "was most injurious, because it was carried by the rising tide up the river to be brought to London by the following ebb-tide, there to mix with each day's past supply, the progress of many days' accumulations towards the sea being almost imperceptible." This exactly describes the existing state of things in Mid-Thames, both in respect to accumulation of sewage, its daily oscillation, and *its slow progress* seaward; the only difference now is, that the nuisance which was formerly brought down to London by the ebb is now carried *up to London* by the flood."

Again: "The evidence of the senses may also be relied on as an important factor for determining the question of purity. While in the neighbourhood of the outfalls, I observed that bubbles of gaseous matter, arising from decomposition, were continually ascending to the surface of the water, reminding me of similar experience in the polluted Clyde. The foul condition of the river was also apparent from the smell caused by the disturbance raised by the steamers' paddles; and the floating abominations by which I was surrounded, when making the test observations, are to be remembered rather than described."

Again: "Contemporary and reliable opinions are all opposed to the practice of discharging crude sewage into rivers."

Again: "Results worked out, and still being worked out in the Thames, by sewage discharge, are evils of great magnitude, and seriously detract from the general value of the Metropolitan sewage arrangements. If certain foul accumulations, formed near to the old sewers at London, led the reporters of 1868 to declare that the evil had attained such proportions as to render it essential to the well-being of the Metropolis that means should be taken for its permanent abatement, what would they say of similar features on a more gigantic scale lower down the river? Observing that the present channel in Mid-Thames is through banks of fetid matter, that the water in the channel is loaded with material in a state of putrescence, and that it daily oscillates within the Metropolitan area, with its teeming population, and contaminates the atmosphere, they would probably admit this to be a state of things altogether detrimental to the public interest. Though it may be very true that the action of land-floods, and the frequent passing to and fro of the steam-traffic of the river, will always maintain a navigable passage through its foul reaches, yet the sides of the channel and the contiguous foreshores must, of necessity, become more foul, and to a greater distance from the outfalls, as the population increases and the water is more highly charged with the accreting matter which sewage contains."

Again: "Nothing can be possibly more unsatisfactory than the present condition of things."

I may add that no effectual remedy is suggested by Captain Calver, though he anticipates that "experimental research and discovery" may bring about "a successful solution of this pressing question."

The report concludes a re-iteration of what has already been advanced, to the effect that the "foul and offensive accretions have recently formed in the channel of the Thames;" and that a "material portion of these accumulations are in the neighbourhood of the metropolitan sewage outfalls;" and he recommends that the Metropolitan Board of Works be called on to dredge away those portions of the accreted matter which interfere with the convenience of navigation, and that they be requested to adopt such arrangements as are calculated to prevent similar accumulations in future." He further hopes that the "noble metropolitan river" may be "freed from a drawback which is impairing its commerce and usefulness."

The report of Captain Calver is met by a lively rejoinder from Sir J. W. Bazalgette, C.B., Engineer to the Metropolitan Board of Works, supported by other scientific men, in which he premises that, "when it is considered that the report in question purports to be, not the exaggerated statements of an advocate, but the calm and deliberate conclusions of a scientific man, upon a matter involving the most serious and vital interests, adopted and

circulated with the authority of a responsible public body, it is impossible to overrate the grave importance which attaches to such statements" as are contained therein.

Again: The Engineer states that, "in order to simplify the subject as far as possible, we propose to direct our enquiry to the following points, viz.:—

"1st. Whether there is any evidence that foul and offensive accretions have formed within the channel of the Thames since the metropolitan sewage outfalls came into operation.

"2nd. Whether careful analyses do show a perfect identity between the constituents of the Thames mud and those of the metropolitan sewage.

"3rd. Whether it is true that the sewage discharged at Barking and Crossness does work its way upwards, and cause the same pollution of the Thames within and about the metropolitan area as formerly existed.

"4th. As to the quantity of solid matter contained in the sewage discharged into the Thames at Barking and Crossness, and whether it is sufficient to produce any sensible deposit in the bed of the river, and as to the real cause of such deposit."

As to the recent formation of foul and offensive accretions, the Engineer argues that comparison of the state of the river thirty years previous to 1861, and that in fifteen subsequent years, has "no value or significance whatever." Further, when it is considered that the traverse sectional areas of the river taken at half-tide off the Crossness outfall have been increased by the removal of shoals," &c., "it would be no matter of surprise if the river in this part of its course should be even more liable to partial deposits forming upon the banks than it was formerly."

He then enters into the subject of the Woolwich shoals, and concludes "that it is obviously impossible to draw the conclusion which Captain Calver suggests, that because mud is found in this part of the river, therefore it comes from the metropolitan sewers." Then as to the mud deposits higher up, near Waterloo Bridge, he remarks "that it is obvious that the deposits of mud above referred to, and which, it appears, accumulated in a few months time, could not have resulted from the sewage discharged into the river upon the ebb-tide at a point no less than 14½ miles lower down the stream."

Next, as to the identity of Thames mud with sewage mud, the Engineer endeavours to show the fallacy of much of Captain Calver's arguments. This is illustrated by a table, from which he (the Engineer) surmises that "it is perfectly obvious that no conclusion can be possibly true which is founded upon the supposed 'perfect identity' of quantities which vary from 0·85 to 40·91."

Then, as to the sewage working upwards, the Engineer quotes a previous paper by Captain Calver, where he himself "proves very distinctly the decided preponderance of the power of the ebb over that of the flood," and points out that the late theory propounded by Captain Calver, to wit, "the operation of accretion has been effected by the superior disturbing and transporting power of the flood stream," is "diametrically opposite and contradictory." He also calls attention to Captain Calver's grammar in regard to his introduction into the English language of the new word "stickability."

The amount of solid matter actually contained in the sewage is then discussed, of which 32 examples were taken from different parts of the Thames, which, being analysed, the Engineer proceeds: "Then taking the average quantity of sewage discharged in the 24 hours, at 120 million gallons, we have, for the weight of solid matter discharged into the river every year, 64,250 tons." A different result from Captain Calver's, which is 465,000 tons.

Again: The rejoinder continues, the quantity of solid matter discharged into the river at the outfalls in each tide is 88 tons, or 1,380 million grains; and the quantity of tidal water passing the outfalls in a spring ebb, as stated by Captain Calver is 108,138,140 cubic yards, or 18,248,311,125 gallons; consequently the amount of solid matter thrown into the river from the outfalls only "amounts to ·076, or $\frac{1}{13}$ of a grain per gallon, a quantity far too small to exercise any appreciable influence upon the purity of the water."

Again: "That the water in the lower reaches of the river is very much loaded with mud, especially upon flood-tide, is a matter of fact which cannot fail to strike any person observing it; and the reason will be very evident upon examining the state of the river banks." Then alluding to the "saltings," that is erosions by waves, having been computed; the cubic contents of the same are estimated, whereby it is found that "at least a million tons of soil are washed into this part of the river every year, in addition to that which is brought down from above."

It is stated that thus the "saltings below London, therefore, supply at least 15½ times as much solid matter as that discharged by the sewage outfalls." This, the Engineer adds, "is, in fact, the real source of the mud deposit on the banks of the river, which, as we have shown, Captain Calver has erroneously attributed to the metropolitan sewage."

The report concludes "that there is *no* documentary evidence to prove that foul and offensive accretions have recently formed within the channel of the Thames;" that, "in fact, the water and mud of the Thames have improved greatly in purity;" that "there is no resemblance between Thames

mud and sewage mud;" that "sewage does not work its way up the river;" and, finally, that "the muddy condition of the river is caused principally by the unprotected state of its banks."

Here, then, we may pause and exclaim, How doctors differ!

Captain Calver supports his statements by numerous tables and analyses, and Sir J. W. Bazalgette does the same in treble volume, hence his chemical referees quaintly conclude their support of their employer by a remark, viz., conclusions of a few samples only (by Captain Calver's analysts) *must be looked upon with great distrust!*

The report of Sir J. W. Bazalgette is accompanied by an appendix containing letters and reports of other authorities, besides plans, charts, and sections of the Thames and its estuary. The evidence of Faraday is brought out as to the former foul state of the Thames within the city precincts, and apart from the question before us the charts of the saltings or erosions of the banks of the Thames estuary are interesting to the physical geographer. And here we may take the liberty of pointing out that, as these all take place below the sewage outfalls, extending for a distance of 20 miles, from which Sir J. W. Bazalgette ascribes the muddy condition of the river above—from this, his own principle, we have a difficulty in clearing him from contradiction, when he ignores Captain Calver's statement in the same direction, viz., that the filthiness of the river above the outfalls, extending up to London, little more than 10 miles, is due to the sewage deposits of Barking Creek and Crossness, which is but a corollary to his own theory.

But, in truth, the controversy is of a kind in which one throws his filth into a neighbour's bed, so complete equanimity is not to be expected, on the contrary, perturbations from the true mean of sound judgment are to be looked for. It is open, therefore, to the enquirer to suppose, that as the sewage issues from the outlets into the Thames with the ebb, weightier particles will be the first to descend to the bed not far from the outlets; hence, may it not be supposed that, when the advancing flood of the heavier salt water, forcing itself beneath the lighter fresh water, yet ebbing at the surface, arrives at the outlets, these weightier particles will be carried up the river to certain distances? In the notesof experiments, on either side of the question, we do not detect that sufficient investigations have been made on this point. It is, therefore, yet unsettled, and can here only be alluded to.

But to the general public this subject carries little interest with it, for to those acquainted with the Thames near London, 25 years ago and now, the enormous improvement in the cleanliness of its waters is palpable.

This was so patent to ourselves that we had scarcely anticipated a most distant demur from any quarter. Leaving this portion then, and proceeding to what we suggest as being the vital point of misunderstanding between the Thames Conservancy and Metropolitan Board, viz., the interruption of navigation, we will tarry a little to examine it.

The official surveys, admitted to be correct by both parties, show changes going on in the river-bed near Barking Creek and Crossness, but that it has shallowed cannot be stated.

The cross-sections at Crossness show a bank as increasing on the Kent side (that is the side at which the sewage falls); and at Barking Creek, a bank increasing on the Essex side (that is the side on which the sewage there falls). But in both cases a deepening to an equal extent has taken place at the opposite sides of shallowing. The section lines are given for the years 1861, 1867, and 1876. At Crossness the soundings of 1861, on the Kent or outfall side, show a decrease of 10 feet, more or less; but on the Essex side an increase in like quantity. At Barking Creek, similar changes have taken place, but to a less degree. Thus exact data do not indicate danger of closing to the channel of the Thames, but only alteration of its bed. That this alteration is due to the new influence brought to bear on it, viz., the issue of large quantities of drain detritus, we think will be admitted by all unprejudiced persons.

But that the navigation of the Thames will be affected from the issue of the drainage of a district at points higher or lower, or the converse, we are not prepared, beyond a certain point, to admit. If the present drainage were not issued at Barking Creek and Crossness, it would have issued above and below London Bridge, carrying with it the same quantity of matter and sediment into the river, and in an equal degree, and no more; depositing the heavier particles in the beds or along the banks continuously; but at the same time continuously acted on by floods and tides, spreading it out from landward to seaward in that equilibrium due to the natural forces at work.

Thus, in the interests of Thames navigation, the question of outfall at London, or at Crossness, 14 miles below it, is of very little consequence. If one deteriorate passage of shipping, so would the other; but if either can be proved to do so, then the City of London would be bound to seek another area for the deposit of its offal. This contingency appears not yet to have arisen.

In prosecuting my enquiries, on the 2nd August last, I proceeded to Abbey Wood, near to which is the outlet of the South London drainage, on a point of the river called Crossness. I arrived there at about noon, and was taken over the works by the manager. The works are situated on a raised

mound, close to the south bank of the Thames, and on which are also erected official and workmen's houses, with a school for the children. The mound is actually a covered tank of six acres in extent, but being covered with earth, and planted with grass, this cannot be detected by a stranger.

The engine-house is a spacious erection of the Byzantine style, the chimney-stalk being of elegant proportions. The power of the engines is 500-horse, and is used in pumping the sewage from the main drain into the tank, by means of eight plunge pumps, of about three feet in diameter. The main drain is 30 feet below the surface, and the tank rises above this, having a depth, when full, of 14 feet.

The sewage is only let out at high-water, on its turn to ebb, and it continues to flow till nearly low-water. There are three outlets for the sewage from the tank into the river, constructed of solid brick and cement, leading to the high-water mark, then by open timber ducts to the low-water mark.

It was near low-water mark when I visited the place, and I could not markedly detect offensive smell, but the water of the river was exceedingly turbid and discoloured.

I also examined the sewage in the tank, through a manhole, and ascertained that but slight offensive odours escaped by this aperture.

I did not consider it necessary to examine the works on the north side of the river, as the principle is merely repeated, but they are larger, the tank there being equal to 10 acres.

The effect of the outfall of city sewage and detritus in a river, then, is similar to what may be readily studied on any goldfield where hydraulic works in simple gold-washings are in force. The sludge does not pen up the rivers of magnitude, but it merely spreads itself out on the banks adjacent to the outfalls, and what it occupies of the original bed, the stream compensates itself by scouring out a deeper channel on the opposite, so that it maintains an equal volume. Limiting the enquiry to navigation, such, in our view, is the influence on the Thames in this much-vexed question.

In regard to its pollution, that is another question. We cannot help opining that Captain Calver is more eloquent on this subject than necessary. That *fetid matter is carried up to the metropolitan area, teeming with population*, contaminating its area, is surely their grievance, not his; and so long as they are contented with the smells in their precincts, the Thames Conservancy need not disturb themselves, but if they can show that ship and barge crews are struck with gastric fever, or otherwise intolerably discomposed by the odours, by passing the outfalls, this comes within their functions to remedy. But no statistics are brought forward on this head, nor are complaints from this quarter even alluded to.

Looking at the question with a bird's-eye view, in our humble opinion

there can-be no question that London, having adopted the water-gravitation system for cleansing its precincts, within practical distance, no sites could have been better chosen for the outfalls than Barking Creek and Crossness, as here the country around is devoid of population, hence the works, if not altogether inoffensive, are placed where they are in a position to give least offence.

Having thus discussed the Home sewage question in its various phases, and noticed the opinions drawn from experimental enquiry, as well as from long experience, we will now turn to the subject as it presents itself in this Colony. Referring to the report published by the Sanitary Commission of Dunedin, dated 25th January, 1865, we find this town principally built of wood, at that time containing 15,087 inhabitants, and whose bad sanitary state was graphically described by the city engineer, the late John Millar, Esq., F.S.A.

The remedies submitted to the Commission by several engineers were as follows:—One assumed, as a matter of course, that the sewage would be "hurried into the harbour," though ultimately the outfall might be on to the ocean beach. Another propounded a scheme of irrigation, conducting the sewage over or through two dividing ranges to the land between Dunedin and Saddle Hill, and in which the Taieri Plain might participate. This was to be effected by a series of pumping engines. Another suggested that the sewage should be discharged at the Lawyers' Head, by means of hydraulic pressure on the drains. Another scheme was to submit the Forbury Flat to a system of high-class farming by the application of liquid sewage.

From this it may be surmised that there was great diversity of opinion amongst engineers as to the proposed measures; but in saying this, it cannot be said to be more so than is or was existent amongst engineers in England at that date. The fact of the matter is, the subject is a growing one, in which time makes changes, and matured experience, we have seen, has suggested alterations.

In this case of Dunedin, we see one engineer proposing to direct a system of irrigation over a plain, which ten short years have converted into a town. Another proposes to fertilize, by a similar scheme, an agricultural district, separated from the town by two ranges of hills, at ten miles distance, a project worthy of the greatest cities in Europe, and only practicable to them. Another proposes to send it into the sea; another into the harbour. It is worthy of note that none proposed a dry system of treatment.

Now it would be wrong to infer, from the want of unanimity in the engineers, that they were incompetent professionally. On the contrary,

the question was not of a technical nature in the first place, and at that time, but of the power to bear taxation on the part of the citizens, in their anticipated progress and increase, in estimating which (a duty of the statistician rather than of the engineer) they may be said to have failed. Study of the various works applied to cities in Europe will illustrate this fact in every direction; but here, also, the lesson cannot escape us. The practical end of all the professional advice given to the Dunedin Commission has been, that the sewage is carried to the nearest available point; that is, into the harbour fronting the city, and into which area it will flow till sufficient opposition has been conjured up to prevent it.

This is the history of older cities; so it is the same of younger.

And continuing our theme, with Dunedin as our example: This city, like London, having adopted the water-gravitation principle of cleansing, the sewage will flow to its assigned levels, till, as in its great prototype, it becomes an intolerable nuisance. Then the city authorities will have to look abroad for projects in its disposal otherwise; and to all of them, from local interests, there will be objections. The question in the end resolves itself, not into attaining a project which has no objections attached to it, but to one which has the least. Hence, as we see in the cities of the Home country, the wearied and puzzled municipalities will have to look to the harbour as an easy solution of their difficulties, but to be opposed by the Boards in charge of this interest. Next, they will look to the ocean beach, to be thwarted by the suburban population and pleasure-seekers of that locality. Perchance, then, imitating the Borough of Brighton, they may have power to tunnel to beyond Tomahawk on the one side, or Green Island on the other; or, taking example by the inland cities of England, such as Birmingham, Leeds, or Bradford, they will discourage the water-gravitation system, and, perforce, purify their sewage before delivering it into the subjacent water of their estuary.

In Christchurch we also have a recent example in the colony of want of unanimity as to measures, the projected scheme only to be thwarted by the ratepayers; the real difficulty being, not what should be done, but what the majority of the several interests will allow to be done.

From this, it might be inferred, that sanitary engineering is at best experimental. To this it may be answered, that it has hitherto been largely so, a necessary concomitant of the modern advance of science, the altered conditions of society, and the variety and complicated arrangements of its requirements. In this, it has been no otherwise with other practical and economical branches, such as railroads, steam navigation, manufacturing enterprises, etc. But large data, the result of experiment and observation, are also now known or accessible to the engineer; hence principles for

guidance under the different difficulties he has to meet, are at hand to support him.

Thus in this colony, when principles are sought for, they will be found to be simple in the main, however complicated the details may be.

Sanitary works resolve themselves into two distinct systems, namely—wet and dry; the former acting by the gravitation of water, the other by manual or machine carriage.

The wet system carries its burden to the sea, or to rivers, when it can do this unopposed; to areas for irrigation in the production of crops; or to waste areas for the purpose of absorption and filtration. The burden may also be brought to tanks for precipitation and the purification of the sewage.

The dry system has its burden carried to the sea, whether by boat or carriage; to the fields for direct application to cultivation, or to works of manure manufacture, for all of which the extracts made in the preceding part of this paper give examples.

The separate systems, suitable for the respective situations, are not difficult to decide on. Where towns have accessible water-supply and easy exits, the wet system is suitable; where these do not exist, the dry system becomes imperative. We use the word imperative, because it is in human nature for people to divest themselves of that which is disagreeable with the least trouble to themselves, and this, when the conditions are favourable, is most readily effected by water. But it has not in all cases proved economical or efficient in the end where water has been had recourse to, owing to the nuisance being cast on other interests, and for which the law when appealed to has demanded a remedy at great cost.

In favour of the dry system one great recommendation is to be said, namely—that it returns to the soil that which man took from it; thus, that it should have a general acceptance by cities in a practical and convenient manner, will always be considered a desideratum.

In New Zealand, more than in almost any other country, the wet system is easily available, districts in which a contrary condition exists being limited to Canterbury, Southland, and Auckland.

The proportion of human excreta to sewage is an important question to sanitary engineers; and taking the data afforded by London, it will be found that these do not exceed one-hundredth part of the whole sewage. This element makes but a small factor in the whole, and is of very secondary consideration, under the circumstances of the city possessing a full water-supply and a ready place of disposal, such as the sea or a tidal river. But in the case of inland towns, where they are forced to purify the sewage, the matter is different; for though the excreta there may only form a small portion of the whole volume to be dealt with, they perforce form a large

part of the nuisances to be got rid of. The proportion of excreta must necessarily vary with the industries and habits of the towns or cities, in manufacturing populations the refuse from factories being great, while with residential populations this must be limited. Hence, in inland towns, we observe the present measures of municipalities discouraging water-closets and promoting some form or other of the dry system.

In a colony such as ours, where new municipalities are being annually incorporated, it is desirable that in their varied responsibilities they should not neglect sanitary reform. Though in the early stages of a town cess-pools are not to be avoided, yet in relation to the health of the people these should, as early as possible, be abolished by law, and in the first place the dry system instituted, until they have obtained a water-supply and fully considered their facilities of removal and the permanent sites to which they could conduct the sewage, with the least offence to interests in their neighbourhood.

APPENDIX, No. 1.

Comparison of the Cost of Disposing of Town Sewage by different Processes, in proportion to the Annual Rateable Value, etc., 1875. Compiled from a Table given in the Report of Committee appointed by the Local Government Board, 1875, page lviii.

Name of Town.	Population (about)	Number of Houses.	Number of Water-Closets.	Annual Rateable Value.	Per £ of Rateable Value.	
					Sewage.	Scavenging.
BY IRRIGATION.						
				£		
1. Banbury	12,000	3,485	2,485	34,104	1d.	—
2. Bedford	18,000	3,500	3,000	65,000	1d.	—
3. Blackburn.. ..	90,000	16,700	730	235,127	8d.	3½d.
4. Cheltenham ..	45,000	8,725	8,500	217,849	½d.	¼d.
5. Chorley	20,000	4,000	200	54,407	4½d.	2½d.
6. Doncaster	20,000	4,300	—	68,721	3½d.	—
7. Harrowgate ..	12,000	1,500	1,620	50,000	5¾d.	—
8. Leamington ..	24,700	4,500	8,370	113,400	5½d.	1d.
9. Merthyr-Tydvil ..	55,000	10,778	8,000	135,000	7½d.	—
10. Rugby	8,400	1,700	1,400	45,000	1½d.	—
11. Tunbridge Wells ..	23,000	5,750	5,635	142,914	10d.	—
12. Warwick	11,000	2,400	2,000	43,339	6½d.	—
13. Wolverhampton ..	71,000	14,000	750	210,000	2d.	1½d.
14. West Derby ..	31,000	—	3,220	163,000	4d.	1¼d.
BY LAND FILTRATION.						
15. Kendal	13,700	2,727	450	£44,600	4d.	—
BY PRECIPITATION.						
				£		
16. Birmingham ..	350,000	83,420	8,000	1,229,844	4¼d.	5¾d.
17. Bolton-le-Moors ..	93,100	18,249	758	311,563	2d.	1½d.
18. Leeds	285,000	57,000	8,000	945,141	4¾d.	4½d.
19. Bradford	173,723	34,000	4,050	745,671	3¼d.	2¾d.
BY THE PAIL SYSTEM.						
				£		
20. Halifax	68,000	11,218	2,600	262,581	—	4d.
21. Rochdale	67,000	14,388	350	222,000	—	8¾d.

Art. IV.—*The Maori Canoe.* By R. C. Barstow.

[Read before the Auckland Institute, 10th June, 1878.]

The time is fast approaching when the Maori will hear only of the weapons, garments, and utensils of his ancestors in traditional story—when the tomahawks, spears, *paroas* will have disappeared—a few meres remaining as decorations or indications of chieftainship—when native *kakahus*, in all their varieties, having ceased to be manufactured, will have perished, and when the stone *toki*, or axe, being indestructible, will remain to be wondered at, but not understood.

Not only will these matters of every-day use be no more, but the grander works—their *pas*, their canoes, their ornamented *whares* will have decayed, and the few surviving fragments of pre-*pakeha* civilization will have to be sought for in our museums.

It is a duty, then, devolving upon us to endeavour to preserve for the information of the future races, both white and Maori, such remnants of history as yet exist, and with this object I have persuaded Paora Tuhaere to lodge here some of the carvings belonging to the once well-known canoe, *Toki-a-tapiri;* and as canoes of that class are now uncommon, I propose to give a short account of their construction, and a word or two as to their history.

Our first accounts of these Islands, resulting from Tasman's voyage to them, more than two centuries ago, brought into notice the canoes of the people; and naturally enough, for what the horse is to the Arab, the camel to the dweller in the desert, the canoe was to the inhabitant of New Zealand; a country abounding in bays, harbours, creeks, rivers, and destitute of roads and beasts of burden. Water-carriage was a matter of prime necessity. In addition to which the dearth of quadrupeds caused fish to be much depended upon as an article of food. Our Waitangi treaty shows how highly the Maori prized his fisheries. But in Tasman's time the canoes he saw were all double; though Cook, who was so much longer on the coasts, if I remember rightly, much more frequently mentions single canoes than double ones, and this latter class must have gone out of fashion soon after Cook's time; for I never heard even the oldest natives mention them as used in their own day, save temporarily, when two might be lashed together for the purpose of erecting a fighting-stage on the platform between them, so as to be able to overtop therefrom the stockade of some water-fronting *pa.*

Canoes occupying such a leading position in native estimation, many of their legends and traditions have reference to them—even the mythical *Ika-o-Maui*, the first drawing up of this island from the ocean, was not to be accomplished without a canoe—the accounts of the seven different canoes

which brought from Hawaiki to this country the progenitors of the present race of Maoris are familiar to most of us; one only of these—the *Tainui*—is always mentioned as being double; and as some ships of *our* navy have been immortalized by the prowess of their crews in celebrated engagements, so many of the Maori *waiatas* or songs are in honour of their ships—most often in praise of their celerity, by dint of which some enemies' *pa* had been surprised, or their women and children carried away into captivity.

Canoes may be divided into four classes—*Waka-taua* or *waka-pitau*, war canoes, fully carved; the *waka-tetee*, which, generally smaller, had a plain figure-head and stern; *waka-tiwai*, an ordinary canoe of one piece, and the *kopapa* or small canoe usually used for fishing, travelling to cultivations, etc.

The *Toki-a-tipiri* belonged to the *waka-pitau*, which differed from the *waka-taua* in having an untatooed figure-head with a protruding tongue, and being less elevated forward.

Canoes, being of vital importance, whether for war, or as a means of procuring food, a superstitious race naturally attributed to the tree set apart for the *hiwi* or hull of the canoe some power over its future fortune; not only was a particular site or aspect in its growth deemed lucky, but it was supposed that incantations by a *tohunga* or wizard bestowed upon the living tree would increase the virtue of the wood when used.

Special trees were sometimes the cause of war between two tribes, were set apart, or made *tapu*, by a father for an infant son, remained even as an heir-loom for the grandson, and occasionally, in early land sales, were specially reserved.

Totara was the tree chiefly prized, on account of its durability. *Kauri* was next in estimation, and in the north was easier to procure of large size. I have seen a *waka-tiwai*—that is, a canoe entirely of one piece, carry, beyond its crew, three-and-a-half tons of potatoes in a seaway. *Kahikatea* was sometimes used; it is light but not lasting, and I have known *rimu* canoes, but these are too heavy to be popular.

When a tree had been selected either by an individual *rangatira* or by a *hapu* who had determined to build a war-canoe, it was first necessary that a sufficient stock of food to supply the workmen employed upon it should be available; if the tree grew in a place distant from the *pa*, a special cultivation as near as possible to the *locus operandi* might be made for the purpose, otherwise a particular patch of *kumera*, or other esculent, was planted and set aside; then the future canoe had to be draughted; certain naval architects were the Symonds or Reeds of their day, and were occasionally fetched from far to design a craft which was required to possess extra speed; many a deliberation of the *Kaumatuas* or elders took place over the prepared model, ere the shape was finally settled.

The next step was to consult the *Tohunga* as to the day for commencing the falling; the state of the moon must be considered; an inauspicious day for beginning would surely cause the canoe to capsize—the *taua* or war-party using it to be defeated, or, if not to be a *waka-taua,* no fish would be caught therefrom.

When stone-axes and fire were the only means of falling the tree, the task of bringing down a *totara* four or five feet through must have been tedious; the first iron hatchets used were those procured from Captain Cook, and those obtained at Manawaora a century ago, when Marion's crew were ashore and slaughtered, whilst getting out a spar; probably it was not till thirty years later that iron-axes became sufficiently abundant to supersede those of stone entirely. Some care was needed that the tree in falling should not be broken nor shaken; an accident of this kind is by no means uncommon, and many fine spars are now lost in this way. The destruction of a specially large tree, after the labour of falling had been incurred, must indeed have been a calamity.

Though when an outlying tree of sufficient scantling could be found, it was preferred to one forest-grown, as our shipwrights considered hedge-grown better than plantation oak; yet, in most instances, the *totara* or *kauri* tree stood in a forest miles from the sea-shore, and so far from *anahingas* or cultivations that relays of women were needed to carry up provisions for the workpeople; a road for hauling out by would also require preparing; secrecy, too, was often needed, for a hostile tribe would be only too glad either to attack the *pa* weakened by the absence of many of its men, or to surround and cut off the party while engaged at work.

At last, however, incessant labour has fallen the tree, cross-cut the log, and dubbed down the outside to somewhat near its destined shape, and fire and adze have partially hollowed out the *riu*, or hold, dry *rewarewa* wood being used for the charring; the amount of excavating done at this stage depending upon the distance to which the canoe has to be hauled and the danger of its splitting on its journey. In peaceable times there is a great feast, and all the friendly neighbouring *pas* contribute hands to haul out, by dint of *akas*, or vines, over rollers or skids, the still weighty mass. The workmen pull together over the steeps to the songs of the women.

It is not always fated to reach the water. At the foot of Wairere Hill, in Whangaroa Harbour, there lay, some years ago, the two sides of a mighty canoe which had been fashioned on the elevated plateau above the bay. Whilst a party of some thirty slaves were engaged in lowering it down the steep hill-side, a vine broke, the canoe rushed headlong to the bottom, and split from end to end; a cry of despair from the awe-stricken slaves brought their *rangatiras* to the spot, and instant death was the punishment meted out to the unlucky slaves for their neglect or misfortune.

But even when the *hiwi*, or bottom piece, has reached the sea beach or creek in safety, but a small portion of the work has been completed. This piece has to be redubbed and further hollowed; this operation, too, is repeated as the timber seasons after the canoe has been in use. Then trees have to be fallen for the *rauawa*, or top streak, not much smaller than the one first mentioned. These top streaks in the *Toki-a-tapiri* are each about seventy feet long, and eighteen or twenty inches deep amidships. These have to be dubbed down to their proper thickness and shape, to be dragged out, and fitted to the hull; holes *(puerere)* require boring through both, so as to lash them along together—a simple enough business with a brace and bit, but a very different matter when *kiripaka* or quartz was used, though the natives had learned to construct a drill armed with this pointed stone; the *tete*, or figure-head, and *rapa*, or stern-piece, have to come, and you have only to look at these to form some notion of the time, taste, and skill requisite for their manafacture; a very slight mistake, an unskilful blow, and the thing is ruined; another seasoned log must be got, and the work be recommenced. It is not everywhere that this carving can be executed. The Arawa and Wakatohea, Bay of Plenty tribes, were long celebrated for their knowledge of designing and carving the ornamental parts of canoes, and their services were obtained by hire, or the requisite carvings (of course I am speaking now of modern days) were procured in exchange for guns, blankets, horses, or European goods. In earlier times raids were made, and men carried as slaves to carve for their masters. Only a small portion of the tracery must be cut out at a time, lest exposure to the sun should cause a crack. A fully ornamented stern-post was months or years even before it received its finishing touch, though the pattern had been sketched from the first. These portions of the craft have to be carefully fitted and bored for seizing on; the *taumanu*, or thwarts—frequently of manukau wood—must be cut, worked out, and lashed to the *niao*, or gunwale. On the proper fitting of these, which took the place of our deck-bearers, much of the strength of the canoe depends, and the women spent days in preparing the *muka*, or flax for these lashings *(kaha)*.

Then along each side of our canoe has to be fitted a batten, called *taka*, covering the joint of the *hiwi* and *rauawa*, and the *kaha* has again to be carried over this so as to secure this streak firmly to the side. These pieces, too, were of great length, some 30 or 40 feet, so as to have only one joint or splice on each side.

Our canoe is now pretty well built, but yet again requires many fittings—the *kaiwae*, stages or platforms, usually made of small manuka sticks, upon which the *kaihoe*, or paddlers, either sat or knelt, a kind of grated deck, running the length of the craft, with openings here and there to

communicate with the *riu*, or hold; one or more of these apertures were supplied with a *tiheru*, or bailer, for toughness' sake made of *mangiao* wood; for many a sea in rough weather would break on board, and were it not for the caulking *(purupuru)* with *huni*, or flower of *raupo*, a supply of which the women had gathered in the swamps, much water would have found its way through the joints and holes. The native substitute for oakum is impervious to wet when properly applied.

The next process is to paint our vessel; and for the prevailing red colour in fashion, *karamea*, a species of clay, which needs to be burnt before being applied, is most valued. The parts to be coloured are first cleaned, then sized with juice of sow thistle and the *poporo* shrub, after which the *karamea*, mixed with water, is rubbed on; this yields the most brilliant colour, and is very lasting. *Kokowai* is a kind of pigment, burnt, dried, and mixed with shark-liver oil. This is a good deal darker than the former.

The batten, carved stern, and head, if a *wakataua*, are usually blackened with powdered charcoal, or lamp-black and oil. The *wakatetee* has usually a red head. On gala days the *taka* would be adorned with albatross feathers, and wreathes of pigeon or wild duck feathers flutter upon the stem and stern.

The equipments are still to follow. According to size, sixty to a hundred paddles are requisite. One very large canoe, formerly in Taraia's possession, could seat 140 paddlers; but the *hiwi* of this was 96 feet long, the projecting stern and stem adding 14 feet to this huge length. It is said that *Toki-a-tapiri* could stow fifty on each side, steer-paddles, too, which are much longer than ordinary ones, and usually with carved handles.

Then the masts *(rewa)*, steps for which have been left when the *riu* was hollowed, with the booms, and cordage, and the queer sails, supposing our canoe was made as far back as forty years ago, must not be forgotten.

These last, ere the days of duck or calico, were made of long leaves of the *raupo*, kept in their places by an interlacing of flax-twine *(aho)*; the butt or wide part of the leaf was uppermost towards the boom, the small ends of the leaves converging to a point at the tack, making thus a triangular sail. Two or three masts were used according to the canoe's length, and small as the amount of sail appeared to be, I have seen a great pace obtained under *raupo* alone.

We yet want a plaited flax cable, and an anchor. Of these last there were three varieties: an oblong stone, with a hole through the smaller end, a stone enmeshed in a netting of flax or vines; or three or four crooked pieces ef *pohutukawa* lashed together with a stone between the shanks and the curved points, forming a rude grapnel.

Sometimes, though the hull might be new, the carved portions of worn-

out canoes would be re-used, being renovated for the occasion; formerly, the stem and stern pieces were detached and stored in sheds when a war-canoe was laid up in ordinary.

Our canoe is now at last ready for launching, nearly as much time having been occupied in its building as would in England have turned out an ironclad; a feast marks the event; and though to the *rangatiras* of the *kainga* the day was one of rejoicing, fifty years back it would have been a poor *hapu* that could not afford a slave or two as a *kinaki*, or relish, for such an occasion.

The canoe is run over the skids into the water and anchored; many are the comments on the way she sits; presently another one is launched, crews of young men are found for each; they paddle out some distance quietly, turn and race back, animated by the cries and gesticulations of the assembled spectators.

As with us a name is fixed upon as soon as the keel has been laid, so, I think, with the Maori; at a very early stage of the work the appellation is agreed upon.

I do not know what led to the name of *Toki-a-tapiri* being given to the canoe to which these carvings belonged. I had hoped to have interested you with a narration of battles in which she had been engaged—though sea-fights were not common—or voyages she had made, but can only tell you that she was built by the Ngatikahungunu, of Hawke Bay, and given by a chief of that tribe to Hone Ropiha, better known as "John Hobbs," during Governor Browne's administration; at that time the canoe was not an old one. Hobbs afterwards sold her to Aihepene Kaihau and other Ngatiteata chiefs at Waiuku for £700. At the commencement of the Waikato war she was seized at Waiuku by a party of volunteers and militia, composed of Messrs. J. C. Firth and others, and brought to Onehunga. She was subsequently conveyed overland to Auckland, by order of the late Mr. John Williamson, when Superintendent, for the purpose of landing H.R.H. Prince Alfred, on the occasion of his first visit to Auckland, and was used by the natives when the Orakei land claim was investigated.

I can only add that her length was some 78 or 80 feet, and beam about 6½ feet.

In Auckland's infant days, twenty or twenty-five of these war-canoes rom the Thames alone might be found hauled up in Mechanics' Bay. Where, alas! are these now?

Art. V.—*Contributions towards a better Knowledge of the Maori Race.*

By W. Colenso, F.L.S.

[*Read before the Hawke Bay Philosophical Institute, 12th August,* 1878.]

——"For I, too, agree with Solon, that 'I would fain grow old learning many things.'"—Plato: *Laches.*

"Though this be madness, yet there is method in't."—*Hamlet.*

On the Ideality of the Ancient New Zealander.

Part I.—Legends, Myths, and Fables.

§ 1. *Introductory.*

I have long been desirous of adding what little I may have gleaned on this subject during an extended sojourn in New Zealand; and I feel still the more inclined to do so through (1) it being now evening time with me, and (2) through my having noticed the many crude theories which have been broached concerning *the Whence of the Maori*, not a few of which, by their several writers, have been laboriously propped and buttressed with all and every item, however insignificant, far-fetched, and vague, they could possibly impress and bring forward, but in which, in my estimation, they have notwithstanding signally failed, because they laboured to build up a pet fancy or hobby of their own rather than the truth; some even starting with assuming the very proposition which they had to prove.*

For my own part, I altogether disclaim all such; I have no pet theory; I only seek the truth; to do what little I may towards establishing it; firmly believing, as I have already written,† that in the years to come this, too, will be found out and known.

For this purpose, then, I shall bring before you on the present occasion a few, out of the many, curious old legends, myths, and fables of the Maori, preferring those which I have known for many years, which have to do with natural and tangible objects, and which have not been tampered with or added to by Europeans, or by Maoris who had imbibed new and foreign ideas.

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* Plenty of this will be found in several volumes of the "Transactions N.Z. Inst.," which, although often attempted to be dressed up in a new fashion, is *not* new. I append a suitable extract on this subject from an old book, as the work itself is scarce and little known:—

"In respect to the New Zealanders, some have imagined that they sprang from Assyria or Egypt. 'The god Pan,' says Mr. Kendall to Dr. Waugh, 'is universally acknowledged. The overflowings of the Nile, and the fertility of the country in consequence, are evidently alluded to in their traditions; and I think the Argonautic expedition, Pan's crook, Pan's pipes, and Pan's office in making the earth fertile, are mentioned in their themes. Query—Are not the Malay and the whole of the South Sea Islanders Egyptians?' To which we reply—When will the spirit of conjecture rest?"—*Beauties, etc., of Nature*, by C. Bucke; new ed., vol. ii., s. 79; London, 1837 (*note*).

† In Essay on The Maori Races; Trans., Vol. I., pp. 61, 62, 1st Ed.

Here, however, let me pause awhile to explain clearly, yet briefly, what I mean by the term *Ideality*: I mean that superior faculty—that conception of the natural and beautiful, the truthful and symmetrical, which has ever been found to pertain to the higher races, or varieties of men, and in particular to the more gifted among them. As Cousin says (*On the Beautiful*): —"The *Ideal* appears as an original conception of the mind. * * * Nature or experience gives me the occasion for conceiving the *ideal*, but the ideal is something entirely different from experience or nature, so that if we apply it to natural, or even to artificial figures, they cannot fill up the condition of the *ideal* conception, and we are obliged to imagine them exact." Kant lays it down—"By *ideal*, I understand the idea, not *in concreto* but *in individuo*, as an individual thing, *determinable* or *determined* by the idea alone."* On this subject, also, Emerson impressively writes:—"I hasten to state the principle which prescribes, through different means, its firm law to the useful and beautiful arts. The law is this: The universal soul is the alone creator of the useful and the beautiful; therefore, to make anything useful or beautiful, the individual must be submitted to the universal mind. * * * Beneath a necessity thus almighty, what is artificial in man's life seems insignificant. He seems to take his task so minutely from intimations of Nature, that his works become, as it were, hers, and he is no longer free. * * * There is but one Reason. The mind that made the world is not one mind, but *the* mind. Every man is an inlet to the same, and to all of the same. And every work of art is a more or less sure manifestation of the same. * * * We feel, in seeing a noble building, much as we do in hearing a perfect song, that it is spiritually organic; that is, had a necessity in nature for being; was one of the possible forms in the Divine mind, and is now only discovered and executed by the artist, not arbitrarily composed by him. * * * The highest praise we can attribute to any writer, painter, sculptor, builder, is, that he actually possessed the thought or feeling with which he has inspired us."† That delightful writer on Art, J. Ruskin—whether considered as artist or art critic—always in love with the Beautiful, and possessing the wonderful power of telling it in such charming language, says:—"I call an idea great in proportion as it is received by a higher faculty of the mind, and as it more fully occupies, and in occupying, exercises and exalts, the faculty by which it is received. * * * He is the greatest artist who has embodied in the sum of his works the greatest number of the greatest ideas." Then Ruskin contrasts the old Venetian worker in glass, with his profusion of design, his personality of purpose, and his love of his art, with the British

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* Crit. Pure Reason.

† Essay on Art.

worker with his mechanical accuracy. "Everything the old Venetian worker made was *a separate thing—a new individual creation*;* but the British worker does things by the gross, and has no personal interest in any one article."†

To this, from the Moderns, I would also add two short extracts from the Ancients. According to Cicero, there is nothing of any kind so fair that there may not be a fairer conceived by the mind. He says:—"We can conceive of statues more perfect than those of Phidias. Nor did the artist, when he made the statue of Jupiter or Minerva, contemplate any one individual from which to take a likeness; but there was in his mind a form of beauty, gazing on which, he guided his hand and skill in imitation of it." (*Orator*, c. 2, 3.) And Seneca takes the distinction between *ἰδέα* and *εἶδος* thus:—"When a painter paints a likeness, the original is his *ἰδέα*—the likeness is the *εἶδος* or image. The *εἶδος* is in the work—the *ἰδέα* is out of the work and before the work."—(*Epist.* 58.)

Possibly some one may say, or think: "Do you really believe that any thing of that kind, or power, ever appertained to the mind of a New Zealander?" And my reply would be: "Yes, undoubtedly, and that in no small degree." And here we must be careful in discerning and considering, in order to arrive at a right conclusion.

The fragment of brown floating seaweed, when properly examined and considered, shows the hand of the Great Artificer as surely as the superb and symmetrical flower of the garden, the admiration of all beholders. In viewing the colossal architecture of the ancient Egyptians, we must beware how we compare it with that of ancient Greece, especially with the airy and flowery Corinthian Order. So, when we contemplate the modern Greek, untaught and unskilled peasant it may be, sauntering among the marble ruins of the cities and capitals of his forefathers, and thoughtlessly breaking up some exquisite creation of the gifted sculptor of ancient days, and the question of doubt arises in our minds as to the possible oneness of that race, we must not forget how sadly, how greatly, they have degenerated. Just so, then, in my estimation, it has been with the nation of the New Zealanders. They, too, have degenerated—sadly, surely, and quickly—particularly within the last half a century:

"'Tis Greece, but living Greece, no more."

But do not mistake me, as if I meant to assert that they in their *Ideality* ever approached to that of the great Western nations which have been mentioned. Not so; but speaking comparatively, and in their degree,

* Much of this *re* the old Venetian workman is truly relatively applicable to the old New Zealand worker.

† Modern Painters.

and according to their own national conceptions, and to the circumstances in which they were placed by nature,—without a written language, or the use of metals, or beasts of burden, or any knowledge of, or communication with, the great world of mankind lying around them,—aye, more ;—without teaching or instruction or communication of ideas (even among themselves !) ;—without the healthy incitement arising from competition with artists of other tribes, and of exhibition, and of praise from afar !—without even a probable certainty of his even completing what he had painfully devised and begun (all such being utterly precluded by their constant wars !) ; and without the slightest excitement of pay or reward, as things were never made for *sale* among them ; and also with having a share (in common with the other members of his tribe) in the almost daily labours attendant on the cultivating and obtaining his food,—from which exertion no New Zealander in health, whatever might be his rank or intelligence, was ever exempt ;—all these things being fairly weighed and considered,—this, this is the way in which they should be judged by us—*

> " They are —— of the works of the Father,
> And of the one Mind the Intelligible.
> For Intellect is not without the Intelligible,
> And the Intelligible does not subsist apart from Intellect."—*Zoroast.*

The Maori of to-day is not worthy, in this respect, to carry the shoes of his forefathers. And he knows it ; he feels it. Ichabod ! or *Fuit Ilium*, may well be called upon them.

I, who have been, I may be allowed to say, long conversant with them, have no hesitation in stating, that the more I have seen and known of the works of the *Ancient* New Zealander, the more have I been struck with the many indications of their superior mind,—of their fine perception of the beautiful, the regular, and symmetrical ; of their desire and labour after the beautiful ; of their prompt and genuine, open and fearless criticisms,—in a word, of their great *Ideality*. And this high faculty of theirs which they possessed in an eminent degree, will probably be better known and understood hereafter than it is at present. It was their possession of that faculty, even in more modern times, which enabled them at a glance, and, as if by inspiration,* to detect inaccuracy or want of æsthetic conformity and exact precision in the skilled performances of their European visitors, and as quickly to declare it ;—as in the martial exercises of the military (regulars), in the want of exact time in the rowing of boats by the most skilful seamen of H.M. navy ;—and, in all their own works, to perceive instantaneously all such want of symmetry if present.

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* I use this word here in the Socratic sense, as by him in Plato, *Ion.*

That faculty was exhibited in many ways, *e.g.* :—

In the building of their war-canoes with all their carving and many adornments; and that *without plan, pattern, or tools.* The exquisite regularity and symmetry of both sides of the vessel, including even that difficult one of carved concentric circles worked in filagree, were astonishing; and, as such, borne ample testimony to by all their first visitors.*

In the building of the highly ornamented houses of their chiefs.

In all their better carvings, with which every article of wood, of bone, of shell, or of stone, was profusely and boldly adorned—from the handle of a working-axe, or spade, to the baler for their canoes. Horace truly says—

> " Pictoribus atque poetis
> Quidlibet audendi semper fuit æqua potestas,"

to which, however, I would also add, *sculptoribus;* unless such may be considered as included in *poetis;* for Plantus affirms, "*Poeta ad eam rem.*"†

In their tattooing.

In their weaving, plain and ornamental, of many kinds and patterns (more than 200) of textile fabrics; and *all* simply done by hand!

In their chequered dogs'-skin, and kiwi-feathered, and red parrots'-feathered, cloaks.

In their making and twisting of threads, cords, lines, and ropes; many varieties of each.

In their ornaments—of feathers,‡ of greenstone, and of sharks' teeth.

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* *Vide* Cook, Forster, Parkinson, and others, *passim*; also, Nicholas' "New Zealand," Vol. I., p. 48; II., p. 49.

† "One of the arts in which the New Zealanders excel is that of carving in wood. They often display both a taste and ingenuity, which, especially when we consider their miserably imperfect tools, it is impossible to behold without admiration. The N. Z. artist has no lathe to compete with, neither has he even those ordinary hand tools which every civilized country has always afforded. The only instruments he has to cut with are rudely fashioned of stone or bone. Yet even with these his skill and patient perseverance contrive to grave the wood into any forms which his fancy may suggest. Many of the carvings thus produced are distinguished by both a grace and richness of design that would do no discredit even to European art. Their war-canoes have their heads and sterns elaborately carved. On their musical instruments much time and labour is bestowed in the shaping, carving, and inlaying."—*The New Zealanders*, pp. 129, 131.

‡ Of their taste in feathers for decoration of the head, we have notable instances recorded. It is well known that the national taste in this respect was severely simple yet graceful.

"*Simplex munditiis.*"—HOR. "Plain in thy neatness."—MILTON.

The New Zealanders preferring the snowy-white plumes of three birds in particular—the white stork, the albatross, and the gannet, and the black feathers, tipped with white, of the *Huia (Heteralocha gouldi)*;—nothing gaudy or of strong glittering colours was approved of by them; otherwise they could easily have manufactured such feathers from several of their indigenous birds. All this we have in the voyages of their earliest visitors, and in the plates. But in the principal plate (or the one ostentatiously intended

In their ornamented staffs of rank, carved and inlaid with mother-of-pearl, and decorated with quillets of flowing dog's hair, and red feathers.

In their symmetrical planting of their food, with faultless regularity, and all done "by the eye."

In their language; hence its great grammatical precision, its double duals and double plurals, its euphony, its rhythm, and its brevity, and its many exquisite particles and reduplications, both singular and plural, all highly pregnant with meaning, which almost defy translation into English.

In many of their songs and recitations; some plaintive and mild and full of love, others bold and martial; all natural and sympathetic.

In their possessing *diesic* modulations, or quarter-tones, in their airs and music.*

In their proverbs and sayings, and quaint laconic effusions; often abounding with wit and beauty of expression and depth of meaning.

In their legends, myths, tales, and fables.

In the regular sequence of their peculiar mythology, and of the beginning and formation of all things; all natural orders of living things having each a separate creator or progenitor.

In their polite and courteous behaviour, and true, open and free hospitality, often exhibiting the true gentleman.†

In their knowledge of many of the operations of nature, including the periodic return of the moon and stars, and the seasons.

In the faultless precision of bodies of them moving together, as if it were but *one* man! as in their paddling and dancing and in several games.

Now in all these matters, and more might be adduced, they ever showed their innate national taste, in which they were vastly in advance of our own British forefathers when first visited by Cæsar; although the Britons had many natural advantages, of which the New Zealander had never dreamed.

To return from our earliest intercourse with the Maori, two or three peculiar and strange traits and circumstances highly characteristic of him have been known. I allude to those respecting his belief in, and fear of, animals of the Saurian or Lizard kind. Settlers and colonists of to-day can form no correct idea of how a bold and daring New Zealand warrior, who feared not to meet his fellow foe in a stern hand-to-hand deadly fight, would blanch and run away in horror from a little harmless lizard! yet

to be such—the frontispiece) to Hochstetter's work on New Zealand (English edition), we have a Maori Chief with three peacock's feathers stuck in his hair!! a proof of their degeneracy in taste; or, as I believe, of the baser (inferior) taste of the English artist, who had merely learnt by rule, and who had no conception of the superior faculty.

* See Appendix to this paper; one highly interesting to trained musicians.

† *Vide* Nicholas' "New Zealand," Vol. I., pp. 24, 25.

this I have often seen. Why was this? was it that he really feared that little harmless animal? or was it that that tiny creature was to him the form and representation of a great, fearful, mischievous, and mysterious power, the deadly foe of man, ever hated and dreaded by all New Zealanders, and called an *Atua*, or demon? of which it was said—aye, and firmly believed—that it often gnawed the internal part of diseased folks, and so surely caused their death; or was it through their belief in those cherished legends of the olden time, that had been strictly handed down through many generations from father to son, containing the history of some dreadful monsters of the Saurian order, and which the prowess of their ancestors, aided by the charms and spells of their priests *(mark this)*, had enabled them to vanquish and to overcome? Animals of such a huge and monstrous size as would comparatively leave the Megatherium and Mammoth far behind in the place of kittens!

And here I cannot help calling your particular attention to a very curious feature, which will prominently appear in the relations I shall have to give you—viz., that while the utmost exactitude is preserved in those strange stories—of time, and place, and persons, and of a certain amount of strong natural reality, yet not a single vestige of any osteological remains of any animal of the Saurian kind has ever yet been discovered! While, on the other hand, the fossil remains of many large and extinct *Struthious* birds of several genera and species, and commonly known in the lump by the name of *Moa*, are to be met with in great abundance; and yet, of these realities, there are neither credible history, nor curious legendary tale, nor myth nor fable, that I have ever been able to lay hold of.

Captain Cook heard something of those large *Saurians* on his third voyage while at anchor in the Straits which bear his name; which, being but brief, I will give in his own words:—"We had another piece of intelligence from this chief, that there are lizards there of an enormous size. He described them as being eight feet in length, and as big round as a man's body. He said they sometimes seize and devour men; that they burrow in the ground; and that they are killed by making fires at the mouth of the holes. We could not be mistaken as to the animal, for, with his own hand, he drew a very good representation of a lizard on a piece of paper, in order to show what he meant." And this statement was further confirmed by Mr. Anderson, the surgeon to the ship, as appears from a *note* appended to that voyage, viz.:—"In a separate memorandum book, Mr. Anderson mentions the monstrous animal of the lizard kind, described by the two young New Zealanders they had on board, after they had left the island."*

* 3rd Voyage, Vol. I., pp. 142, 153.

Mr. Nicholas, who accompanied Mr. Marsden on his first visit to New Zealand in 1814, says:—"While in the forests at the Bay of Islands, observing a hole at the foot of one of the trees, which evidently appeared to have been burrowed by some quadruped, we inquired of Kena what animal he supposed it was; and from his description of it, we had reason to believe that it must be the Guana. Wishing to know how far our surmise was correct, we desired our friend to thrust a stick into the hole, and endeavour to worry the animal out of it; but this he tried with no effect, for either it was not in the hole at the time, or, if there, not to be dislodged by such means. Kena, however, was rather well pleased than otherwise at not meeting with this animal; for his dread of it was so great, that he shrunk back with terror at the time he thought it would come out, nor did he examine the hole but with very great reluctance. This we thought very strange, for the Guana (the animal we took it for) is perfectly harmless. * * * The chief, Ruatara, however, informed us that a most destructive animal was found in the interior of the country, which made great havoc among the children, carrying them off and devouring them, whenever they came its way. The description he gave of it corresponded exactly with that of the alligator. * * * The chief had never seen the animal himself, but received his accounts from others; and hence it appears to me very probable that his credulity might have been imposed upon."*

Captain Cruise, of the 84th Regiment, who came to New Zealand in H.M.S. 'Dromedary' five years after Mr. Nicholas, and who resided in this country ten months, gives in a few words an interesting notice of the abject fear exhibited by the Maori at the mere sight of a small lizard! which, as it is (or was) so truthful—as I have too often myself witnessed—I also quote:—"A man who has arrived at a certain stage of an incurable illness, is under the influence of the *Atua*, who has taken possession of him, and who, in the shape of a lizard, is devouring his intestines; after which no human assistance or comfort can be given to the sufferer, and he is carried out of the village and left to die. * * * This curious hypothesis was accidentally discovered by one of the gentlemen, who, having found a lizard, carried it to a native woman to ask the name of it. She shrunk from him in a state of terror that exceeded description, and conjured him not to approach her, as it was in the shape of the animal he held in his hand that the *Atua* was wont to take possession of the dying, and to devour their bowels."†

In various parts of this island, but all to the north of Napier, I have had shown me when travelling (1834–1844), many spots where it was said monsters of the Saurian Order had formerly dwelt.

* *Narrative*, Vol. II., pp. 124, 126.

† Journal, pp. 283, 320.

Thirty-five years ago, when journeying along the East Coast, between Cape Kidnappers and Castle Point, on reaching the top of the high hill or range situated between Waimarama and Te Apiti, named Marokotia, my attention was called to a remarkable rift or chasm at the head of the glen just below me, on the east or sea side of the old Maori track or pathway. This, I was told by the old chiefs of the coast who were with me, was in ancient times the dwelling of a monster Saurian, named Hinehuarau; that it burst away from this place, tearing and rending all before it, and so went on south until it reached Wairarapa, where it was subsequently killed by a chief of note of ancient days, named Tara, whose name he gave to the lake near Te Aute, "Te Roto-a-tara."

Some time after I was again in the Wairarapa Valley, and hearing so much of the "bones," or, as some said, "the head," of this monster being yet to be seen in the place where it was slain, away among the hills, I purposely walked thither from a village called Hurunuiorangi to see them. It was rather a long and rough walk to the place among the hills on the other side of the Ruamahanga river. Arriving there, I found the said "bones" to be a heap or knob of yellowish, friable, glittering, quartz-like stone (calcite), which cropped out from the hill-side and lay in large lumps. I remember well how angry one old Maori became, who was of the party with me, on my asserting that the pile before us was not bone at all but stone. Very likely those natives had never seen any other stone like it (up to that time I had not). It bore, at first sight, a resemblance to the yellow decaying bones of a whale. I think the spot was called Tupurupuru, and that it is not very far from the head waters of the river Taueru.

Such places, however—caves, rifts, chasms, and strange-looking stones—are by no means unfrequently met with in travelling in New Zealand, especially when journeying (as I was obliged to do) along the old foot-paths, which mostly led over ridges of hills; and there are plenty of such stories concerning them, each spot having its own peculiar myth or legend, which was once most certainly believed.

I have also more than once seen another curious spot in this neighbourhood (Hawke Bay), which deserves recording, the more so, perhaps, from the fact of its being no longer to be seen as I saw it. It was on the low undulating grassy banks of the river Waitio. There, at that time, was a huge earthwork representation of a *ngarara*, or *ika*, *i.e.*, a lizard, or crocodile, which, several generations back, had been cut and dug and formed in the ground by a chief of that time named Rangitauira, who, in doing so, had also dexterously availed himself of the natural formation of the low alluvial undulations in the earth. It had the rude appearance of a huge Saurian extended, with its four legs and claws and tail, but crooked,

not straight, as if to represent it wriggling or living, and not dead. It was many yards in length, and of corresponding width and thickness, and by no means badly executed. On two occasions, in particular, in travelling that way, as we generally rested there on the banks of the stream, the old Maori chiefs with me would diligently use their tomahawks and wooden spades in clearing away the coarse grass and low bushes growing on it in its more salient parts, so as to keep its outline tolerably clear, reminding me of what has been said of the periodical scouring in the Vale of the White Horse. The natural vegetation of the place was well suited for the purpose of preserving it, being mostly composed of our (Hawke Bay) common carpet or mat grass *(Microlæna stipoides)* and a low-growing *Muhlenbeckia (M. axillaris)**, but in those days no foot of man trod on it, and of beasts there were none!

This curious earth-work was called Te Ika-a-Rangitauira, that is, that that Saurian outline was made or formed by a chief whose name was Rangitauira. He was an ancestor of the chief Karaitiana (M.H.R.), and of several other chiefs and sub-tribes now living here in Hawke Bay; he lived nineteen generations back; one of his residences was a large *pa* called Te Mingi, on the Tutaekuri river. He formed this design, or earth-work (which originally consisted of *three* Saurian outlines) in remembrance of his having returned from that spot with his fighting party. They had left their own *pa* to attack another on the east side of the Tukituki river, but being here overtaken by daylight abandoned their design. First, however, forming and leaving there those three monsters, to indicate to the people of the *pa* they had set out to attack, how they had intended to serve *(i.e.* devour) them. This chief subsequently met with his death in returning from the Patea country in the interior, through being overtaken by a violent snowstorm, and taking refuge in a cave called Te Reporoa (on the *lower* passes of the Ruahine mountain range) where he and those with him miserably perished in the snow! His younger brother, who persevered and kept on his journey, escaped. Consequently for many years this chief's huge earthwork was attended to and kept clear of coarse weeds by his descendants in commemoration of him.

I now proceed to give you some of those old legendary tales, for which I have been preparing the way, premising that these are all fair translations from the original Maori as I received them, and without any addition. Like most translations, however, they lose much of their striking original character and beauty in attempting to clothe them in a foreign dress.

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* It was here that I discovered that pretty little and very scarce plant, *Stackhousia minima*.

§ 2.—*Tales.*

THE STORY OF THE DESTRUCTION OF MONSTERS.

1. *The Slaying of Hotupuku.*

Here is the tale of the valiant deeds of certain men of old, the ancestors of the chiefs of Rotorua. Their names were Purahokura, Reretai, Rongohaua, Rongohape, and Pitaka; they were all the children of one father, whose name was Tamaihutoroa. As they grew up to manhood they heard of several persons who had been killed in journeying over the roads leading by Tauhunui and Tuporo, and Tikitapu,—all places of that district.

People of Rotorua who had travelled to Taupo, or who went into the hill country to meet their relations, were never again heard of; while the folks of the villages who were expecting them were thinking all manner of things about their long absence, concluding that they were still at their respective places of abode; but, as it afterwards turned out, they were all dead in the wilderness!

At last a party left Taupo on a visit to Rotorua, to travel thither by those same roads where those former travelling parties had been consumed. Their friends at Taupo thought that they had arrived at Rotorua, and were prolonging their stay there; but no, they, too, were all dead, lying in heaps in that very place in the wilderness!

Afterwards another travelling party started from Rotorua to Taupo; this party went by the lakes Tarawera and Rotomahana, and they all arrived safe at Taupo. On their arrival there many questions were asked on both sides respecting the people of Taupo who had gone to Rotorua, but nothing whatever could be learned of them. On hearing this the people of Taupo earnestly enquired of the newly-arrived party from Rotorua, by what road they came? They replied, "We came by the open plain of Kaingaroa, by the road to Tauhunui." Then it was that the people of Taupo and the party from Rotorua put their heads together, and talked, and deeply considered, and said, "Surely those missing travellers must have fallen in with a marauding party of the enemy, for we all well know they have no kinsfolk in those parts." Upon this the Taupo people determined on revenge, and so they proceeded to get together an army for that purpose, visiting the several villages of Taupo to arouse the people. All being ready, they commenced their march. They travelled all day, and slept at night by the road-side; and the next morning, at daylight, they crossed the river Waikato. Then they travelled on over the open plain of Kaingaroa until they came to a place called Kapenga, where dwelt a noxious monster, whose name was Hotupuku. When that monster smelt the odour of men, which had been wafted towards him from the army by the wind, it came out of its cave. At this time the band of men were travelling onwards in the

direction of that cave, but were unseen by that monster; while that monster was also coming on towards them unseen by the party. Suddenly, however, the men looked up, and, lo! the monster was close upon them; on which, they immediately retreated in confusion. In appearance, it was like a moving hill of earth! Then the fear-awakening cry was heard, "Who is straggling behind? Look out, there! A monster, a monster, is coming upon you!" Then the whole army fled in all directions in dire dismay and confusion at seeing the dreadful spines and spear-like crest of the creature, all moving and brandishing in anger, resembling the gathering together of the spines, and spears, and spiny crests, and ridges of the dreadful marine monsters of the ocean. In the utter rout of the army, they fell foul of each other through fear, but, owing to their number, some escaped alive, though some were wounded and died. Then, alas! it was surely known that it was this evil monster which had completely destroyed all the people who had formerly travelled by this way.

The news of this was soon carried to all parts of the Rotorua district, and the brave warriors of the several tribes heard of it. They soon assembled together, 170 all told, took up their arms, and marched even until they came to Kapenga in the plain, and there they pitched their camp. Immediately they set to work, some to pull the leaves of the cabbage-tree *(Cordyline australis)*, others to twist them into ropes; then it was that all the various arts of rope-making were seen and developed!—the round rope, the flat rope, the double-twisted rope, the three-strand rope, and the four-sided rope*; at last the rope-making was ended.

Then the several chiefs arose to make orations and speeches, encouraging each other to be brave, to go carefully to work, to be on the alert, and to be circumspect, and so to perform all the duties of the warrior. All this they did according to the old and established custom when going to fight the enemy.

One in particular of those chiefs said—Listen to me, let us go gently to work; let us not go too near to the monster, but stay at a distance from it, and when we perceive the wind blowing towards us over it, then we will get up closer, for if the wind should blow from us to the monster, and it smells us, it will suddenly rush out of its cave, and our work and schemes will be all upset." To this advice the chiefs all assented, and then the men were all properly arranged for each and every side of the big rope snare they had contrived and made, so that they might all be ready to pull and haul away on the ropes when the proper time should come.

* This was still the custom in late years; their strongest common ropes were made from the leaves of the cabbage-tree, after steeping them in water, and a strong and very peculiar kind of 4-sided rope was made by them of it. I have had such made for me, but I almost fear the art is lost. Flax (or *Phormium)* leaves would not be suitable.

Then they told off a certain number to go to the entrance of the cave where the monster dwelt, while others were well armed with hard-wood digging spades* and clubs, with long spears, and rib-bones of whales, and with short wooden cleavers or halberts. Last of all, they carefully placed and laid their ropes and nooses, so that the monster should be completely taken and snared in them; and then, when all was ready, the men who had been appointed to go up to the mouth of the cave to entice and provoke the creature to come forth, went forwards; but, lo! before they had got near to the cave, the monster had already smelt the odour of men.

Then it arose within its cave. And the men who had gone forth to provoke it heard the rumbling of its awful tread within the cave, resembling the grating noise of thunder. Notwithstanding, they courageously enticed it forwards by exposing themselves to danger and running towards it, that it might come well away from its cave; and when the monster saw the food for its maw by which it lived, it came forth from its den ramping with joy.

Now this monster had come fearlessly on with open mouth, and with its tongue darting forth after those men; but in the meanwhile they had themselves entered into the snares of ropes, and had passed on and through them, and were now got beyond the set snares—the ropes, and nooses, and snares, all lying in their proper positions on the level ground.

At this time those men were all standing around below when the huge head of the beast appeared on the top of the little hill, and the other men were also ascending that hill and closing in gradually all around; the monster lowered his head awhile and then came on, and then the men, the little party of provokers, moved further away on to the top of another hillock, and the monster following them entered the snares! At this the men on that little hill stood still, then the monster moved on further and further towards them, climbing up that ascent also, so that when its head appeared on the top of that second hillock its fore legs were also within the set loops of the big snare.

Then it was that the simultaneous cry arose from the party who were standing on the top of the little hill watching intently, "Good! capital! it has entered! it is enclosed! pull! haul away!" And that other party, who were all holding on to the several ropes, anxiously waiting for the word of command, hearing this, pulled away heartily. And, lo! it came to pass exactly as they all had planned and wished for—the monster was caught fast in the very middle of its belly.

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* This implement (called a *ko*) might be just as well termed a lance, or pick; it was narrow, pointed, and 6-7 feet long, and used for digging fern-root, &c., and sometimes, as here, as an offensive weapon.

Now it began to lash about furiously with its tail, feeling more and more the pain arising from the severe constriction of its stomach by the ropes.

Then the bearers of arms leaped forth. A wonderful sight! The monster's tail was vigorously assaulted by them; they stabbed it over and over with their hardwood digging picks and their long spears, and pounded it with their clubs, so that even its head felt the great amount of pain inflicted on its tail, together with that arising from the severe constriction of the ropes on its softer parts. Now the monster began to rear and to knock about dreadfully with its head; on seeing this, the enticing band of provokers, who had still kept their position in front, again began to entice it to make straight forward after them, by going up close to it and then running away from it, when, on its attempting to stretch out after them, they suddenly faced about in a twinkling, and began to play away upon the monster's head with very good effect. Oh! it was truly wonderful to behold!

By this time, too, the party of rope-pullers had succeeded in making fast all their ropes to the several posts they had fixed in the earth all round about for that purpose; this done, they also seized their weapons and rushed forward to assist their comrades in beating the monster's head—this being now the part of it which reared and knocked about the most violently. Now, the assault on its head was carried on alternately by those men, combined with the others who began it, and who for that purpose divided themselves into two parties, when one party rushed forward and delivered their blows, and the hideous head was turned towards them, and they fell back a bit, the other band came on on the other side and delivered their battery, either party always beating in the same place. After a while the monster became less vigorous, although it still raged, for its whole body was fast becoming one vast mass of bruises through the incessant and hearty beating it was receiving.

Still the fight was prolonged; prodigies of strength and valour, ability, and nimbleness were shown that day by that valiant band of 170, whose repeated blows were rained upon the monster. At last the monster yielded quietly, and there it lay extended at full length on the ground, stretched out like an immense white larva* of the rotten white pine wood, quite dead.

By this time it was quite dark; indeed, night. So they left it until the morning. When the sun appeared they all arose to cut up this big fish.† There it lay, dead! Looking at it as it lay extended, it resembled a very

* The word is *huhu*. I suppose this large grub has been selected for a comparison owing to its dying helplessly extended, and its plump, fat appearance.

† I have translated this word *(ika)*, wherever it occurs in the story, by "*fish*," this being one of its principal meanings; but it would carry a very different one to a New Zealander. Here it would be just synonymous with whale, or large marine animal.

large whale,* but its general form or appearance was that of the great lizard,† with rigid spiny crest, while the head, the legs, feet, and claws, the tail, the scales, the skin, and the general spiny ridges, all these resembled those of the more common lizards *(tuatara)*. Its size was that of the sperm whale *(paraoa)*.

Then this man-devouring monster was closely looked at and examined for the first time—the wretch, the monster, that had destroyed so many persons, so many bands of armed men and travelling parties! Long, indeed, was the gazing; great was the astonishment expressed. At last, one of the many chiefs said, "Let us throw off our clothing, and all hands turn to cut up this fish, that we may also see its stomach, which has swallowed so many of the children of men.‡

Then they began to cut it open, using obsidian and pitch-stone knives, and saws for cutting up flesh made of sharks' teeth, and the shells of sea and of fresh-water mussels *(Unio)*. On the outside, beneath its skin, were enormous layers of belly fat (suet), thick and in many folds. Cutting still deeper into its great stomach or maw, there was an amazing sight. Lying in heaps were the whole bodies of men, of women, and of children! Some other bodies were severed in the middle, while some had their heads off, and some their arms, and some their legs; no doubt occasioned through the working of the monster's jaws and the forcible muscular action of its enormous throat in swallowing, when the strong blasts of its breath were emitted from its capacious and cavernous belly.

And with them were also swallowed all that appertained to them—their greenstone war-clubs, their short-knobbed clubs of hardwood, their weapons of whales' ribs both long and short, their travelling staves of rank, their halbert-shaped weapons, their staffs and spears—there they all were within the bowels of the monster, as if the place was a regular stored armoury of war. Here, also, were found their various ornaments of greenstone for both neck and ears, and sharks' teeth, too, in abundance *(mako)*. Besides all those there were a great variety of garments found in its maw: fine bordered flax-mats; thick impervious war-mats, some with ornamented borders; chiefs' woven garments made of dogs' tails, of albatross feathers, of *kiwi* feathers, of red (parrot) feathers, and of seals' skin, and of white dogs' skin; also, white, black, and chequered mats made of woven flax, and garments of undressed flax *(Phormium)*, and the long-leaved *kahakaha (Astelia*, species*)*, and of many other kinds.

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* *Nui tohora.*

† *Tuatete*, the angry, frightful lizard, now extinct.

‡ *Uri-o-Tiki:* literally, descendants of Tiki: Tiki being, in their mythology, the creator or progenitor of man.

All the dead bodies, and parts of bodies, the conquerors scooped out and threw into a heap, and buried in a pit which they dug there. And that work over they proceeded to cut up the fish into pieces; and when they had examined its fat and suet, they expressed its oil by clarifying it with heat, which was eaten by the tribe; and so they devoured and consumed in their own stomachs their implacable foe. This done, they all returned to Rotorua and dwelt there.

2. *The Killing of Pekehaua.*

After the destruction of the monster Hotupuku, the fame of that exploit was heard by all the many tribes of the district of Rotorua. Then a messenger was sent to those heroes by Hororita, or by some other chief, to inform them that another man-eating monster dwelt at a place called Te Awahou, and that the existence of this monster was known, just as in the former case of the one that dwelt in the plain at Kaingaroa. The travelling companies of the districts of Waikato and of Patetere were never heard of; and so the travelling companies of the Rotorua district, which left for Waikato, were also somehow lost, being never again heard of. When the people of Rotorua heard this news, those same 170 heroes arose, from out of many warriors, and set forth for Te Awahou. Arriving there, they sought for information, and gained all they could. Then they asked, "Where does this monster dwell?" The people of the place replied, "It dwells in the water, or it dwells on the dry land, who should certainly know; according to our supposition, no doubt it is much like that one which was killed."

Hearing this, they went to the woods, and brought thence a large quantity of supplejacks *(Rhipogonum scandens)*, with which to make water-traps of basket-work. Those they interlaced, and bound firmly together with a strong trailing plant (*Muhlenbeckia complexa*), so that when they were finished the traps consisted of two or even three layers of canes or supple-jacks. Then they twisted ropes wherewith to set and fix the water-traps, in order to snare the monster, and these were all done. Then they made similar plans and arrangements for themselves, as on the former occasion when the first one was killed. All being ready, the band of heroes set out, reciting their forms of spell, or charms, as they went along; those were of various kinds and potencies, but all having one tendency, to enable them to overcome the monster. Onwards they went, and after travelling some distance, they neared the place, or water-hole, where it was said the monster lived; the name of that deep pool is Te Warouri (*i.e.*, the Black Chasm). They travelled on until they gained the high edge of the river's side, where they again recited their charms and spells, which done, the 170 proceeded to encamp on that very spot.

Then they diligently sought out among themselves a fearless and courageous man, when a chief named Pikata presented himself and was selected. He seized the water-trap, which was decorated on the top and sides and below with bunches of pigeons' feathers; the ropes, also, were all fastened around the trap, to which stones were also made fast all round it, to make it heavy and to act as an anchor and to keep it steady; and, having seized it, he plunged into the water with his companions, when they boldly dived down into the spring which gushed up with a roaring noise from beneath the earth. While these were diving below the others above were diligently employed in performing their several works, viz., of reciting powerful charms and spells,* of which they uttered all they knew of various kinds and powers, for the purpose of overcoming the monster.

Now it came to pass that, when the spines and spear-like crest of the monster had become soft and flaccid, through the power of those spells and charms, for they had been all erect and alive in full expectation of a rare cannibal feast, Pitaka and his chosen companions descended to the very bottom of the chasm; there they found the monster dwelling in its own nice home; then the brave Pitaka went forwards, quite up to it, coaxing and enticing, and bound the rope firmly around the monster; which having done, lo! in a twinkling, he (Pitaka) had clean escaped behind it! Then his companions pulled the rope, and those at the top knew the sign, and hauled away, and drew up to the top their companions, together with the monster, so that they all came up at one time. Nevertheless, those above had also recited all manner of charms for the purposes of raising, lifting, and upbearing of heavy weights, otherwise they could not have hauled them all up, owing to their very great weight.

For a while, however, they were all below; then they came upwards by degrees, and at last they floated all together on the surface. Ere long they had dragged the monster on shore on to the dry land, where it lay extended; then they hastened to hit and beat with their clubs the jaws of this immense fish. Now this monster had the nearer resemblance to a fish, because it had its habitation in the water.

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* Upwards of ten kinds of spells are here, and in other parts of these stories, particularly mentioned by name; but as we have nothing synonymous in English, their *names* cannot be well translated, and it would take as many pages of MS. to explain them. Among them were spells causing weariness to the foe, spells for the spearing of *taniwhas* (monsters), spells for the warding off attack, and for the protection of the men from the enemy; spells for causing bravery, for returning like-for-like in attack, for uplifting feet from ground, for making powerless, etc., etc., all more or less curious, but mostly very simple in terms. Of spells and charms, exorcisms and incantations—for good or for ill-luck, for blessing and cursing—the ancient New Zealander possessed hundreds, ingeniously contrived for almost every purpose; few, however, if any, of them could be termed prayers. Such form a bulky history of themselves.

So then went forth the loud pealing call to all the towns and villages of the Rotorua district. And the tribes assembled on the spot to look at and examine their implacable foe. There it lay dragged on to the dry land on the river's side, in appearance very much like a big, common whale. Yet it was not exactly like a full-grown old whale; it was more, in bulk, as the calf of a big whale as it there lay.

They then commenced cutting-up that fish as food for themselves; on laying its huge belly wide open there, everything was seen at one glance, all in confusion, as if it were the centre of a dense forest.* For, going downwards into its vast stomach, there lay the dead, just as if it were an old bone-cave with piles of skeletons and bones—bones of those it had swallowed in former days. Yes, swallowed down with all their garments about them, women and children and men! There was to be seen the enormous heap of clothing of all kinds; chiefs' mats of dogs' tails and of dogs' skins—white, black, and chequered—with the beautiful woven flax-mats adorned with ornamental borders, and garments of all kinds. There were also arms and implements of all kinds†; clubs, spears, staves, thin hardwood chopping knives, white whalebone clubs, carved staffs of rank, and many others, including even darts and barbed spears, which the monster had carried off with its food. There these arms and implements all were, as if the place were a store-house of weapons or an armoury!

Then they proceeded to roast and to broil, and to set aside of its flesh and fat in large preserving calabashes, for food and for oil; and so they devoured their deadly enemy all within their own stomachs; but all the dead they buried in a pit.

Then every one of those valiant warriors returned to their own homes. The name of that village, where they were for a while encamped, was Mangungu (*i.e.*, broken bones).

So much for thy victorious work! O thou all-devouring throat of man, that thou shouldest even seek to eat and to hunt after the flesh of monsters as food for thee!

3. *The Killing of Kataore.*

When the fame of those victors who had killed the monster Pekehaua reached the various towns and villages of Tarawera, of Rotokakahi, and of Okataina, the people there were filled with wonder at the bravery of those men who had essayed to destroy that terrible and malicious man-devourer.

Then they began to think, very likely there is also a monster in the road to Tikitapu, because the travelling companies going by that place to Rotorua

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* The words are: "Koteriu o Tane-Mahuta;" *lit.*, the hollow stomach, or centre of Tane-Mahuta—*i.e.*, the god of forests; Tane-Mahuta being the god of forests.

† Ten kinds are here enumerated, all of hardwood and hard white whale's-bone.

are never once heard of; their relations are continually enquiring, "Have they arrived at the place to which they went?" but there is no response; therefore they are dead. Hence it follows that the sad thought arises within, were they killed by some monster? or, by some travelling man like themselves? or, by some armed marauding party of the enemy?

But the chief of Tikitapu and of Okareka, whose name was Tangaroamihi, knew very well all along that there was a monstrous beast at Tikitapu, although he did not know that the beast there residing ate up men; the chief always believed that it dwelt quietly, for it assumed the very air of peace and quietness whenever the chief and his men went to the spot where it dwelt to give it food; and that beast also knew very well all its feeders, and all those who used it tenderly and kindly. Nevertheless, when they had returned from feeding it to their village, and any other persons appeared there going by that way, then that monster came down and pursued those persons and devoured them as food.

Now the manner of acting of this ugly beast was very much like that of a (bad) dog which has to be tied to a stick (or clog). For its knowledge of its own masters was great; whenever its master, Tangaroamihi, went there to see it, its demeanour was wholly quiet and tractable, but when people belonging to another and strange tribe went along by that road, then it arose to bark and growl at them; so that, what with the loud and fearful noise of its mouth, and the sharp rattlings of its rings and leg-circlets, great fear came upon them, and then he fell on them and ate them up.

Now when the multitude everywhere heard of the great valour of those men, the tribes all greatly extolled them, and wondered exceedingly at the prodigious powers of those four chiefs.

Then it was that the chiefs of Rotokakahi, of Tarawera, of Okataina, and of Rotorua began to understand the matter, and to say, "Oh! there is perhaps a monster also dwelling in the road to Tikitapu, because the travelling parties going from those parts to Rotorua, as well as those coming from Rotorua to these five lakes, are never heard of." For when the travellers went to Rotorua by the road of Okareka they safely arrived thither; and so when they returned by that same way of Okareka they reached their homes in safety;—but if the travellers went from Tarawera to Rotorua by the road of Tikitapu, they never reached Rotorua at all; somehow they always got lost by that road.

And so again it was with the people from Rotokakahi, travelling thence to Rotorua; if they went by the road leading by Pareuru, they safely arrived at Rotorua, and also in returning from Rotorua; if they came back by that same road, they reached their villages at Rotokakahi in safety; somehow, there was something or other in that road by Tikitapu which

caused men's hearts to dislike greatly that way, because those who travelled by it were lost and never heard of.

Therefore, the hearts of those who remained alive began to stir within them, so that some even went as far as to say—"Perhaps that chief Tangaroamihi has killed and destroyed both the travelling parties and the armed parties who travelled by the way of Tikitapu." But that chief Tangaroamihi had shown his hospitality and expressed his kindly feeling to the enquirers who went to his town to seek after those who were missing.

Now, however, when the suffering people heard of the exceeding great valour of those four chiefs in their slaying of monsters, then they considered how best to fetch them to come and to have a look at Tikitapu.

So their messenger was sent to those brave heroes, and when they heard from him the message, they all bestirred themselves, that same 170, for they were greatly delighted to hear of more work for them in the line of slaying monsters. So they immediately commenced preparations for their journey to Tikitapu, some in pounding fernroot, some in digging-up convolvulus roots, some in taking whitebait (*Galaxias attenuatus*), and some in dredging freshwater mussels, all to be used as food on their journey to Taiapu, to the mount at Moerangi, for Moerangi was the place where that noxious beast called Kataore dwelt.

In the morning, at break of day, they arose and started, taking their first meal far away on the great plain, at a nice kind of stopping-place. When they had scarcely finished their meal they commenced conversation with the usual talk of warriors on an expedition; for at this time they did not exactly know whether it was really by a monster, or by the people who dwelt thereabouts, that all those who had travelled by that road, whether armed parties or whether singly, had been destroyed.

When this armed party took their journey, they also brought away with them the necessary ropes and such things, which had been previously made and got ready. They knew that such (as they had heard) was the evil state of all the roads and ways of that place, therefore they sat awhile and considered, knowing very well the work they had in hand.

However, when the eating and talking were ended, they again arose and recommenced their march. They entered the forest and traversed it, quitting it on the other side. Then the priests went before the party to scatter abroad their spells and charms, that is to say, their Maori recitations. But they acted just the same on this as on former occasions already related.

They recited all the charms and spells they had used against both Hotopuku* and Pekehaua, going on and reciting as they went; at last

* Though not once mentioned or alluded to in that story.

they made up their minds to halt, so they sat down. Then it was that the people in the villages, under the chief Tangaroamihi, gazed watchfully upon that armed party there encamped, thinking it was a party of their enemies coming to fight and to kill; but in this they were deceived, it being altogether a different party.

A long time the party remained there, watching and waiting, but nothing came. At last one of the chiefs got up and said—"Whereabouts does this noxious beast that destroys men dwell?" Then another of those chiefs replied—"Who knows where, in the water, or in the stony cliff that overhangs yonder?" On this they set to work, and closely examined that lake; but alas! the monster was not to be found there; nevertheless, the appearance of that water was of a forbidding fearful character, that is to say, the fear was caused by the peculiar glitter of the water, as if strangely and darkly shaded, having the appearance of the water whence the greenstone is obtained. But notwithstanding all that, they could not detect any kind of chasm or deep dark hole in all that lake, like the hole in which Pekehaua was found.

Then certain of the chiefs said to the priests, "Begin, go to work; select some of your potent charms and spells." So those were chosen and used; the priests recited their charms, causing stinging like nettles, and their charms of stitching together, so that the bubbles might speedily arise to the surface of the lake, if so be that the monster they sought was there in the water. At this time one of the priests arose, upon the word spoken forth by one of the chiefs of the party, and said, "It is all to no purpose; not a single burst, or rising, or bubble has arisen in the water of Tikitapu."

Then they turned their attention upwards to the stony cliff which stood before them; when, before they had quite finished their spell, causing nettle-stinging, and were reciting their lifting and raising charms, a voice was heard roaring downwards from the overhanging precipice at Moerangi, as if it were the creaking of trees in the forest when violently agitated by the gale; then they knew and said, "Alas! the monster's home is in the cave in the stony cliff."

Upon this the whole body of 170 arose and stood ready for action; for glad they also were that they had found food for their inner man. In their uprising, however, they were not forgetful, for they immediately commenced reciting their powerful charms and spells; all were used, of each and every kind—none were left unsaid; the several priests made use of all,* that being their peculiar work.

They now set to work, and soon they got near to the entrance of the

* Seven or eight kinds of charms and spells are here also particularized, and then the remainder given in a lump.

cave in the rock where this noxious cannibal beast dwelt. At last they got up to the cave, where the whole band quietly arranged themselves, and took a long time to consider how to act. At length the valiant, fearless men arose—men who had already bound monsters fast—and, seizing the ropes, went forward into the cave. There they saw that noxious beast sitting, and staring full at them; but, oh! such fearful eyes! Who can describe them? In appearance like the full moon rising up over the distant dark mountain range; and when gazed at by the band, those hideous eyes glared forth upon them like strong daylight suddenly flashing into the dark recesses of the forest. And, anon, lo! they were in colour as if clear shining greenstone were gleaming and scintillating in the midst of the black eye-balls! But that was really all that gave rise to the appearance of fear, because the creature's spines and crest of living spears had become quite flaccid and powerless, through the potent operations of the many weakening spells which had been used by those numerous warriors, that is to say, priests.

Then they managed to put forth their hands stealthily over its huge head, gently stroking it at the same time. At length the rope was got round the monster's neck and made secure; another rope was also slided further on below its fore-legs, and that was firmly fixed; twice did those brave men carry ropes into the cave. Having done all this they came out to their friends, those of the 170 warriors who had been anxiously waiting their return, and who, when they saw them emerge, enquired, "Are your ropes made fast?" They replied, "Yes; the ropes are fastened to the monster; one round the neck and one round the middle." Then the enquiry arose, "How shall the dragging of it forth from its cave, and its destruction, be accomplished?" When some of the chiefs replied, "Let us carry the ropes outside of the trees which grow around, so that, when the monster begins to lash and bound about, we shall be the better able to make them fast to their trunks." Then others said, "All that is very good, but how shall we manage to kill it?" Some replied, "Why should we trouble ourselves about killing it? Is it not so fastened with ropes that it cannot get away? Just leave it to itself; its own great strength will cause it to jump violently about, and jerk, and knock, and beat itself; after that, we having made the ropes fast to the trees, the destroyers can easily run in on it and kill it; or, if not, let us just leave it alone to strangle itself in the ropes." So all this was carried out by those 170 brave warriors.

Then the several men having been all properly placed, so as to hold and handle and drag the ropes effectually; the word of command was given, "Haul away!" and then they all hauled with a will! But, wonderful to behold, entirely owing to the cave being in the face of the perpendicular

cliff, almost simultaneously with the first pull, lo! the monster was already outside of the entrance to the cave. But then, in so saying, the potent work of the priests in reciting their raising and uplifting charms must be also included in the cause of the easy accomplishment. The moment that the monster's great tail was outside clear of the cave, then its head began to rear and toss and plunge, frightful to behold! On seeing this, they loosened a little the rope that held it by its middle; when, lo! its head was close to the trees, against which it began to lean, while it knocked about its tail prodigiously. The men, however, were on the watch, and soon the two ropes were hauled tightly up around the trees, notwithstanding the jerkings and writhings of its huge tail. There, at last, it was, lashed fast close to the trees, so that it could only wriggle a little that is to say its tail.

Then the armed men came on; they banged and beat and clubbed away at the monster, which now lay like a rat caught in the snare of a trap; and it was not long before it was quite dead, partly through the blows and bruises, and partly through the ropes; and so it came to pass that it was killed.

The fame of this great exploit was soon carried to all those tribes who had fetched and sent Purahokura on his errand to Tikitapu. Then they assembled at the place, and saw with astonishment their deadly foe lying on the ground, just like a stranded whale on the sea-shore, even so this noxious monster now lay extended before them. Then arose the mighty shout of derision from all both great and small, the noise was truly deafening, loud sounding, like that arising from the meeting together of the strong currents of many waters!

Early the next morning the people arose to their work to cut up their fish; then was to be seen with admiration the dexterous use of the various sharp-cutting instruments—of the saw made of sharks' teeth, of the sea mussel-shells, of the sharp pitch-stone knives, of the freshwater mussel-shells, and of the flints. Truly wonderful it was to behold, such loads of fat! such thick collops! This was owing to the cannibal monster continually devouring men for its common food at all times and seasons; it never knew a time of want or a season of scarcity; it never had any winter, it was always a jolly harvest time with it! How, indeed, should it have been otherwise? when the companies of travellers from this place and from that place were continually passing and repassing to and fro; therefore it came to pass that its huge maw was satiated with food—not including the food given to it by its master Tangaroamihi—and therefore it came to be so very fat.

So the big fish was cut up. As they went on with their work, and got

at length into its stomach, there the cannibal food which it had devoured was seen! there it lay—women, children, men—with their garments and their weapons. Some were found chopped in two, both men and weapons; no doubt through the action of its terrible lips in seizing them! others were swallowed whole, very likely through its capacious mouth being kept open, when the strong internal blasts from its great gullet drew down the men into its stomach! For you must also know, that this cave is situated near to the water, so that whenever a party came by water paddling in their canoe to Tikitapu, and the canoe came on to the landing place, this monster, Kataore, seeing this, came out of its cave, and, jumping into the water, took the canoe with the men in it into its stomach, so that both men and canoe were devoured instantaneously!

The victors worked away until they had taken everything out of its big maw, both the goods (of clothing and instruments as before) and the dead; the dead they buried in a pit. Then they finished cutting up that big fish; some of it they roasted and broiled; and some they rendered down in its own fat, and preserved in calabashes; and so it came to pass that it was all eaten up, as good food for the stomach of man.

But when the news of this killing was carried to the chief Tangaroamihi, to whom this pet Saurian belonged, and he heard it said to him,—"What is this they have done; thy pet has been killed?" The chief enquired, "By whom?" and they answered, "By the tribe of Tama" (Ngatitama). On hearing this the heart of Tangaroamihi became overcast with gloom, on account of his dear pet which had been killed; and this deed of theirs was a cause of enmity and war between Tangaroamihi and those who had destroyed his pet; and it remained and grew to be a root of evil for all the tribes. Thus the story ends.

It should be briefly noticed, in conclusion, that the name of this chief (Tangaroamihi), is one highly suited to the *event;* or it may have been given to him at an earlier date, through his having a pet reptile. *Tangaroa* is the name of the god, or creator or father and ruler, of all fishes and reptiles; (though Punga is sometimes spoken of as a god possessing similar powers, but perhaps over only a certain natural section of those animals;*) and *mihi* means, to show affection for, or to lament and sigh over, any one,—present or absent, living or dead;—so that Tangaroamihi might mean, (1) that this chief lamented over the death of one of Tangaroa's family, or tribe; or (2) that he ever liked and showed great affection towards one of them.

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* *Vide* the beginning of the following fable,—"The Shark and the large Lizard," and the note there.

§ 3.—*Fables.*

1.—*The Fable of the Shark and the Large Lizard*—(Guana).

In days of yore the large lizard and the shark lived together in the sea, for they were brothers, both being of the children of Punga.* The lizard was the elder and the shark the younger. After some time they fell out, and as the quarrel was great and protracted, the lizard, vexed at the conduct of his younger brother, determined to leave off dwelling in the sea, and to reside on the dry land, so he left the water.† But just as he had got on the shore, his brother the shark swam up to where he was on a rock, and wished him to return, saying—"Let you and I go out to sea, to the deep water." The lizard replied, with a bitter curse, saying—"Go thou to the sea, that thou mayst become a relish of fish for the basket of cooked roots.‡ On this, the shark retorted with another curse, saying—"Go thou on shore that thou mayst be smothered with the smoke of the fire of green fern."‖ Then the lizard replied, with a laugh, "Indeed, I will go on shore, away up to the dry land, where I shall be looked upon as the personification of the demon-god Tu,§ with my spines and ridgy crest causing fear and affright, so that all will gladly get out of my way, hurrah!"

2. *The Battle of the Birds.*—(A Fable of the Olden Time.)

In ancient days, two shags met on the seaside. One was a salt-water bird and the other was a fresh-water bird; nevertheless, they were both shags, living alike on fish which they caught in the water, although they differed a little in the colour of their feathers. The river-bird, seeing the sea-bird go into the sea for the purpose of fishing food for itself, did the

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* According to the Maori mythology (in which each portion, or kingdom, of Nature had a different origin or progenitor), Punga was the father, or former, of fishes and reptiles.

† Darwin, in his "Naturalist's Voyage" (ch xvii.), writing of the large aquatic lizard (*Amblyrhynchus cristatus*), has some curious remarks very applicable here.

‡ "Roots" is not in the original, which has merely "*kete maoa*"—basket of cooked (food, understood); but the meaning is fernroot, or sweet potatoes. Our common potatoes were not then known to the New Zealander, otherwise I should have preferred that word. "Sweet potatoes" (or *kumara*) would not answer well, as this food was not in use all the year round; and "vegetables" would mislead, as such were never alone cooked save in times of great scarcity. The allusion is as to the Maori manner of serving-up and setting food before men, each basket having a bit of fish or flesh, as a savour, placed on the top.

‖ I had often heard of the old mode of capturing this (the edible) lizard, which lived in holes (burrows) at the foot of trees, and was made to appear by smoking them out; forty years ago this animal was still being eaten by an inland tribe named Rangitane. (*Vide ante, extract from Cook, p. 83, and from Nicholas, p. 84.*

§ *Tu* was the name of the New Zealand god of war.

same. They both dived repeatedly, seeking food for themselves, for they were hungry; indeed, the river-bird dived ten times, and caught nothing. Then the river-bird said to his companion, "If it were but my own home, I should just pop under water and find food directly; there never could be a single diving there without finding food." To which remark his companion simply said, "Just so." Then the river-bird said to the other, "Yes, thy home here in the sea is one without any food." To this insulting observation the sea-bird made no reply. Then the river-bird said to the other, "Come along with me to my home; you and I fly together." On this both birds flew off, and kept flying till they got to a river, where they dropped. Both dived, and both rose, having each a fish in its bill; then they dived together ten times, and every time they rose together with a fish in their bills. This done the sea-bird flew away back to its own home. Arriving there it immediately sent heralds in all directions to all the birds of the ocean, to lose no time but to assemble and kill all the fresh-water birds, and all the birds of the dry land and the forests. The sea-birds hearing this assented, and were soon gathered together for the fray. In the meanwhile, the river-birds and the land and forest birds were not idle; they also assembled from all quarters, and were preparing to repel their foes.

Ere long the immense army of the sea-birds appeared, sweeping along grandly from one side of the heavens to the other, making such a terrible noise with their wings and cries. On their first appearing, the long-tail fly-catcher *(Rhipidura flabellifera)* got into a towering passion, being desirous of spearing the foe, and danced about presenting his spear on all sides, crying "*Ti! ti!*"* Then the furious charge was made by the sea-birds. In the first rank came, swooping down with their mighty wings, the albatross, the gannet, and the big brown gull *(ngoiro)*, with many others closely following; indeed, all the birds of the sea. Then they charged at close quarters, and fought bird with bird. How the blood flowed and the feathers flew! The river-birds came on in close phalanx, and dashed bravely right into their foes. They all stood to it for a long time, fighting desperately. Such a sight! At last the sea-birds gave way, and fled in confusion. Then it was that the hawk soared down upon them, pursuing and killing; and the fleet sparrow-hawk darted in and out among the fugitives, tearing and ripping; while the owl, who could not fly by day, encouraged, by hooting derisively, "Thou art brave! thou art victor!";† and the big parrot screamed, "Remember! remember! Be you ever remembering your thrashing!"‡

* Its faint little note, uttered as it hops, and twirls, and opens its tail.

† "*Toä koë! toä koë!*" was the owl's cry, which the words a little resemble.

‡ "*Kia iro! kia iro koe!*" was the cry of the parrot.

In that great battle, those two birds, the *tiitii (Haladroma urinatrix*=petrel), and the *taiko*,* were made prisoners by the river-birds; and hence it is that these two birds always lay their eggs and rear their young in the woods among the land-birds. The *tiitii* (petrel) goes to sea, and stays away there for a whole moon (lunar month), and when she is full of oil, for her young in the forests, she returns to feed them, which is once every moon. From this circumstance arose with our ancestors the old adage, which has come down to us, "*He tiitii whangainga tahi;*" literally, *A tiitii of one feeding;* meaning, Even as a *tiitii* bird gets fat though only fed well *once now and then.*†

APPENDIX.—*Note to p. 82.*

This is an astonishing fact, but it is strictly true, though, I believe, scarcely known. I, therefore, with great pleasure, give in a note an extract or two from an interesting letter "*On the Native Songs of New Zealand,*" written nearly twenty-five years ago, by a talented musician and author of several works on music (Mr. J. H. Davies, of Trinity College, Cambridge), which letter was printed as an appendix to one of Sir G. Grey's works on New Zealand; and though highly worthy of being read and of being deeply studied—especially by a trained musician—it is, I fear, but very little known among us.

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* Of this bird, the *Taiko*, I have formerly often heard, particularly at the northern parts of the North Island, but have never seen one. It is scarcely known here in Hawke Bay, save by name to a few of the oldest natives. An old chief at Te Wairoa told me that he had known of two which were seen together on the shore of Portland Island (Hawke Bay), many years ago, one of which was snared and eaten. From another very old chief I had heard of two having been once cooked in a Maori earth-oven as a savoury mess for a travelling party of rank; and from his story it would appear as if the bird could have been easily taken in its habitat, at the will of the lord of the manor; for, on that travelling party arriving at the *pa*, one of the chiefs' wives remarked, "Alas! whatever shall I do for a tit-bit to set before our guests?" The chief said, "I'll get you some." He then went out and soon returned with two *Taikos*, which were cooked and greatly relished. This bird is said to have been large, plump, and fat, and highly prized for food, and only to be obtained on exposed oceanic headlands and islets. (There are small rocky islets called by its name, *Motutaiko*.) Possibly it may be a large species of petrel or puffin; although, if the imperfect Maori relation is to be depended on, its beak was more that of an albatross.

† This proverb would be used by the New Zealanders on various occasions; such as (1) When chiefs of lower rank would bring a present (annual, perhaps, as of sweet potatoes [*kumara*] at harvest-time), to their superior chief: (2) When a travelling party arrives at a village, and something particularly good, or extra, which perhaps had been stored up or set by, or just obtained with difficulty or labour, should be given to the party; on such occasions the proverb might be used. Much like (here) our sayings of, "We don't kill a pig every day;" "In luck to-day;" "Just in time," &c.

First, Mr. Davies writes of "the enharmonic scale of the ancient Greeks" (which has long been lost, and which, indeed, has been disputed), that "it consisted of a quarter-tone, a quarter-tone and an interval of two tones, an interval somewhat greater than our third major;" and that this long-lost ancient scale has been found to exist among the Arabians, the Chinese, and the *New Zealanders.*

"As the highest art is to conceal the art and to imitate nature, that mighty nation the Greeks, with an art almost peculiarly their own, having observed these expressions of natural sentiment," stated fully in the preceding paragraph, "thence deduced certain laws of interval, by which, while they kept within the limits of art, they took care not to transgress those of nature, but judiciously to adopt, and as nearly as possible to define, with mathematical exactness, those intervals which the uncultured only approach by the irregular modulation of natural impulses. * * * Hence, I conceive the reason of the remnant of that scale being found among most of those nations who have been left to the impulses of a 'nature-taught' song rather than been cramped by the trammels of a conventional system—the result of education and of civilization."

"*Plutarch* remarks, that the most beautiful of the musical genera is the enharmonic, on account of its grave and solemn character, and that it was formerly most in esteem. *Aristides Quintilian* tells us it was the most difficult of all, and required a most excellent ear. *Aristoxenus* observes that it was so difficult that no one could sing more than two dieses consecutively, and yet the perceptions of a Greek audience were fully awake to, and their judgment could appreciate, a want of exactness in execution."

"Mr. Lay Tradescant, speaking of the Chinese intervals, says that 'it is impossible to obtain the intervals of their scale on our keyed instruments, but they may be perfectly effected on the violin;' * * * and our own ears attest that, universally, in the modulations of the voice of the so-called savage tribes, and in the refined and anomalously studied Chinese, there are intervals which do not correspond to any notes on our keyed instruments, and which to an untrained ear appear almost monotonous."

"Suffice it to say that many Chinese airs, of which I have two, show the diesic modulation and the saltus combined; but the majority of the New Zealand airs which I have heard are softer and more 'ligate,' and have a great predominance of the diesic element."

"One thing, however, is certain, that, as Aristoxenus tell us, no perfect ear could modulate more than *two* dieses at a time, and then there was a 'saltus' or interval of two tones, and as the New Zealand songs frequently exhibit more than *two* close intervals together, it is more than probable that many of these songs are a chromatic."

"In proof that a system of modulation like the above still survives, I shall produce as nearly as my ear could discern, the modulation of some of the New Zealand melodies. * * *

"I here beg to state, that though with great care and the assistance of a graduated monochord, and an instrument divided like the intervals of the Chinese *kin*, I have endeavoured to give an idea of those airs of New Zealand which I heard, yet so difficult is it to discover the exact interval, that I will not vouch for the mathematical exactness. * * * I must also, in justice to myself, add, that the singer did not always repeat the musical phrase with precisely the *same* modulation, though without a very severe test this would not have been discernible, nor then to many ears, the general effect being to an European ear very monotonous. But I may say that, when I sang them from my notation, they were recognised and approved of by competent judges, and that the New Zealander himself said, 'he should soon make a singer of me.'"*

Mr. Davies has also, in his letter, given some of our Maori New Zealand songs, set by him to music, as examples.

I may here also mention, that one of the earliest scientific visitors to New Zealand, Dr. Forster, who accompanied Captain Cook on his second voyage, has left a statement on record of a similar kind. Here is a short quotation from it, given, partly on account of the learned German's feeling and truthful deduction therefrom, and partly because his valuable work is scarcely known in the Colony. (And, to the everlasting honour of the good Doctor, it is to be further noted, that he does this immediately after relating several acts of killing and cannibalism perpetrated by the New Zealanders on Europeans, among which was the very recent one, in which ten seamen belonging to Captain Cook's expedition were killed, etc., so that Dr. Forster did not allow his reason to be carried away by his feelings.) He says,—"The music of the New Zealanders is far superior in variety to that of the Society and Friendly Islands. * * * The same intelligent friend who favoured me with a specimen of the songs at Tongatapu, has likewise given me another of the New Zealand music; and has also assured me that there appeared to be some display of genius in the New Zealand tunes, which soared very far above the wretched humming of the Tahitian, or even the four notes of the people at the Friendly Islands." (Two specimens of their tunes set to musical notes are then given.) "The same gentleman likewise took notice of a kind of dirge-like melancholy song, relating to the death of Tupaea." (The musical notes of this, with the words, are also given.)

* [NOTE.—See "Polynesian Mythology and Ancient Traditional History of the New Zealand Race, as furnished by their Priests and Chiefs." Appendix, p. 313. By Sir George Grey; Murray: London, 1855.—ED.]

"They descend at the close from *c* to the octave below in a fall, resembling the sliding of a finger along the finger-board of a violin. I shall now dismiss this subject with the following observation,—that the taste for music of the New Zealanders, and their superiority in this respect to other nations in the South Seas, are to me stronger proofs in favour of their heart, than all the idle eloquence of philosophers in their cabinets can invalidate."—*Forster's Voyage*, vol. II., pp. 476–478.

Art. VI.—*On the Ignorance of the Ancient New Zealander of the Use of Projectile Weapons.* By W. Colenso, F.L.S.

[*Read before the Hawke Bay Philosophical Institute, 9th September*, 1878.]

I have read Mr. C. Phillips' paper "On a peculiar Method of Arrow Propulsion amongst the Maoris,"* and as Mr. Phillips has referred to a very brief remark made by me in my essay "On the Maori Races,"† and is evidently unacquainted with the old state of things which obtained in this country with regard to *missiles*, I have thought it right to say a few words on this subject in this paper.

First, however, I would briefly remark, that in my writing that essay I appended thereto a quantity of "Notes," all elucidatory of many of the statements I had made therein. Somehow those "Notes" were not printed with the essay—a matter I have greatly deplored, for it was wholly incomplete without them. Had they been printed with it, then Mr. Phillips would have found related the circumstance which gave rise to my remark quoted by him, of the New Zealanders "throwing fiery-headed darts at a *pa* (or fort) when attacking it." That note I shall give in this paper further on.

It should be perfectly well known to us all that the first European visitors to New Zealand found the people utterly without the bow and arrow, and the sling, and, indeed, the common frequent use of the small dart or javelin, as an offensive projectile weapon. And all of those early visitors had ample opportunities of knowing this, for they were often attacked themselves by the New Zealanders, both on land and on water, when such missile weapons were never once used.

At the same time it should be observed, that whenever a canoe, or a body of natives, came up with Cook, whether at sea or on land, and were for fighting, a single spear was invariably thrown; this, however, was by way of challenge *(taki)*, and was in accordance with their national custom; just equal to the old European one of throwing down the gage.

This non-use of prepared missiles appeared the more strange to the Europeans, from the fact of such weapons (slings and darts) being com-

* Trans. N. Z. Inst., Vol. X. 97.

† Trans. N. Z. Inst., Vol. I., p. 15 of the essay; 2nd ed., p. 352.

monly used as weapons of attack in the South Sea Islands, which Cook and his companions had but lately left. While the use of the bow and arrow, for sport, was also known to some of those islanders.

Captain Wallis, who discovered Tahiti in 1767 (two years before Cook first visited it and New Zealand), was fiercely attacked by the Tahitians, who surrounded his ship with "a fleet of more than 300 canoes, carrying 2,000 men." On that occasion (when Wallis was in danger, and only saved by his big guns), the islanders commonly used powerful slings, with which they did some execution even in a ship of war. Captain Wallis says:—"The canoes pulled towards the ship's stern, and began again to throw stones with great force and dexterity, by the help of slings, from a considerable distance; each of these stones weighed about 2lbs., and many of them wounded the people on board, who would have suffered much more if an awning had not been spread over the whole deck to keep out the sun, and the hammocks placed in the nettings." Their bows and arrows, however, they did not use on that occasion during the fight. Further on Captain Wallis adds:—"Their principal weapons are stones, thrown either with the hand or sling, and bludgeons; for though they have bows and arrows, the arrows are only fit to knock down a bird, none of them being pointed, but headed only with a round stone."*

Sydney Parkinson, who was with Cook on his first voyage, gives a drawing of the Tahitian sling (Pl. 13, fig. 1), and a description of it. He says:—"Their sling is about four feet long, made of plaited twine, formed from the fibres of the bark of a tree; the part which holds the stone is woven very close, and looks like cloth, from which the string gradually tapers to a point."†

Captain Cook, in 1769, thus speaks of the use of the bow and arrow by those Tahitians:—"Their bows and arrows have not been mentioned before, nor were they often brought down to the fort. This day, however, Tupurahi Tamaiti brought down his, in consequence of a challenge he had received from Mr. Gore. The chief supposed it was to try who could send the arrow farthest; Mr. Gore, who best could hit a mark, and as Mr. Gore did not value himself upon shooting to a great distance, nor the chief upon hitting a mark, there was no trial of skill between them. Tupurahi, however, to show us what he could do, drew his bow and sent an arrow, none of which are feathered, 274 yards, which is something more than a seventh and something less than a sixth part of a mile. Their manner of shooting is somewhat singular; they kneel down, and the moment the arrow is discharged drop the bow."‡

* Wallis's Voyage; Cook's Voyages, Vol. I., pp. 444–448.

† Journal, p. 75. ‡ Cook's Voyages, Vol. II., p. 147.

And this is what he says respecting the New Zealanders, after having been some time among them :—" The perpetual hostility in which these poor savages live has necessarily caused them to make every village a fort. * * * These people have neither sling nor bow. They throw the dart by hand, and so they do stones ; but darts and stones are seldom used except in defending their forts. * * * But it is very strange that the same invention and diligence which have been used in the construction of places so admirably adapted to defence, almost without tools, should not, when urged by the same necessity, have furnished them with a single missile weapon, except the lance, which is thrown by hand ; they have no contrivance like a bow to discharge a dart, nor anything like a sling to assist them in throwing a stone, which is the more surprising, as the invention of slings, and bows and arrows, is much more obvious than of the works which these people construct, and both these weapons are found among much ruder nations, and in almost every other part of the world. The points of their *long* lances are barbed, and they handle them with such strength and agility that we can match them with no weapon but a loaded musquet.''*

Sydney Parkinson has an excellent remark on this subject (excellent in more ways than one), which I also quote, in the hope that future writers on " the whence of the Maori," will take a note of it. He says—" Something has already been mentioned respecting the language of the New Zealanders, and of its affinity with that of the people of Tahiti, which is a very extraordinary circumstance, and leads us to conclude that one place was originally peopled from the other, though they are at near 2000 miles distance. * * * The migration was probably from New Zealand to Tahiti, as the inhabitants of New Zealand were totally unacquainted with the use of bows and arrows till we first taught them, whereas the people of Tahiti use them with great dexterity, having, doubtless, discovered the use of them by some accident after their separation ; and it cannot be supposed that the New Zealanders would have lost so beneficial an acquisition if they had ever been acquainted with it."†

It must not be overlooked that two Tahitians (Tupaea and his son Taiota) were with them on this occasion. Tupaea not only aided the English considerably as interpreter, but was often *facile princeps* during the whole of their long stay among the New Zealanders. So, again, on Cook's second voyage from Tahiti to New Zealand, he had on board a native of Porapora (one of the Society Isles), named Mahine, who came on with him to New Zealand.

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* Cook's Voyages, Vol. II. p. 345 ; III. 466.

† Parkinson's Journal, p. 75.

Dr. Forster, who accompanied Cook on his second voyage round the world, has given us a full account of the weapons of the people of Tanna, an island they discovered and spent some time at on their third voyage from Tahiti to New Zealand. There, at Tanna, not only darts and slings were used in warfare, but also bows and arrows. And, again, subsequently, when at New Caledonia (which island Cook also discovered during that voyage), Dr. Forster gives another interesting account of the very peculiar manner in which those natives threw their darts, and, also, their prepared stones from slings.*

Mr. Nicholas, who was in New Zealand with Mr. Marsden in 1814, and who spent several months in the country travelling about, and seeing all that was to be seen, saw no projectile weapon used by the natives save their common hand spears. And Major Cruise, during his ten months' residence, is also equally silent about any missiles used by them in their warfare, although as a military officer, in command of soldiers, anything of that kind would be sure to have attracted his notice.

We gather the same from Rutherford's Journal. This witness had ample opportunities during his long sojourn of ten years among the New Zealanders, during which time he got fully tattooed and lived wholly *á-la-Maori*, in his frequent travellings with the Maoris from place to place in the interior, and from his having been a witness of several severe and bloody battles. Curiously enough, Rutherford was at the great battle fought at Kaipara between the Ngatiwhatua and the Ngapuhi tribes, in which the savage and murderous chief Hongi was present, commanding the Ngapuhi, and in which fierce battle Hongi's son, Hare, was slain, and his head, with others, carried off in triumph by Rutherford's Maori party from the East Coast; that battle was fought in the year 1825. Rutherford is in many respects a truthful witness, as I have good reasons for saying, having formerly traced out not a few of his statements. To the above I might add the uniform testimony of all the first missionaries, who saw quite enough of bloody work; and of Polack,† who resided a few years in New Zealand;

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* See appendix A for these extracts which I make, as Forster's Voyage is a scarce work; and, also, believing they may be of service hereafter.

† Polack says:—"The weapons employed in the native warfare were not remarkable for beauty or variety, and are now entirely laid aside. The bow and arrow found among all savage nations were unknown in the country, where numerous woods exist admirably fitted for the formation of such universally known weapons. Slings, another implement that did much execution, were also unknown." (Vol. II., pp. 28-29). Polack is a writer whom I should scarcely ever think of quoting, not merely on account of his being comparatively modern (in my writing of the *ancient* New Zealander) but owing to his many errors; had he contented himself with giving us plainly what he *saw*, without colouring (for he travelled a little while in New Zealand), and without attempting anything of science or history, theology or language, or the drawing of deductions,(!) for all which he was totally unfitted, then his observations would have been of real service.

but I will here close with my own, and that for two reasons: 1. That I had early travelled more than any one in New Zealand (the North Island), leaving few spots unvisited, and had used my eyes and ears in so travelling; and that I had also witnessed their manner of fighting and of attack; 2. That it was our custom at an early date (1834-1840), seeing we were but few then in number in the land, and could not possibly go everywhere—to collect young Maoris from all parts, and to teach them at our principal mission stations in the Bay of Islands, and then, when taught, return them to their homes and tribes; and that many of our Maori servants and labourers, amounting to some scores, or hundreds, were from those who had been taken young in war (of whom a large number we got liberated and returned to their homes), and from them I had often their vivid and interesting recitals of those battles and sieges, with every minutiæ; and my own testimony is this (the same indeed as that of Cook and others) that *the New Zealander never knew the use of the bow and arrow, nor of the sling proper*, as used, for instance, by the natives of Tahiti.

As to the use of the little instrument called a *kotaha* (sometimes a *kopere*, though, more properly speaking, the *kopere* was that by which the *kotaha* was thrown.") I have ever had very grave doubts of its being a true New Zealand implement; for the endeavonr to learn something about it (when first prosecuting my enquiries 40-45 years ago) always ended in disappointment. On this head I could say a good deal, but for the present I forbear.

Here, however, are a few things that should not be lost sight of in this investigation: 1. That in all those *old* Maori tales of fightings and battles and sieges, and especially the killing of monsters (*taniwhas*, some of which I have lately translated), while every possible weapon known to the old Maori, both of offence and defence, including even walking-sticks, is always carefully noticed, nothing of the kind in question (*missiles*) save plain common hand-spears, are ever mentioned;* and yet, for those very purposes, no other weapon would have been so useful. 2. That just as the old New Zealanders were early taught how to use the bow and arrow (and, no doubt, the sling also, by Tupaea and Taiota), as Parkinson says, so were they in after years taught how to make and use the bow and arrow, by myself and other of the early missionaries, as implements of sport for the boys, both of the mission families and of the Maori families living with us. I have made several for them, but the young Maoris of that day *never took to it*, from the fact of its not being a national weapon, and not falling in with the genius of the Maori. 3. That from the beginning of this century, or even earlier, the New Zealanders went often abroad in ships as visitors,

* And even these darts, it should be observed, are not spoken of as *thrown* at the *taniwhas*.

especially to New South Wales; indeed, a very extensive intercourse was then and for many years carried on between Port Jackson and New Zealand, partly owing to the whale and seal fishery.* 4. That on Mr. Marsden's visit (1814) several foreigners were residing in New Zealand; mention is particularly made, among others, of a Tahitian,† and a Hindoo, who were dwelling with the Maoris as Maoris, and who had quite made this country their home, without a wish to leave it; Major Cruise also, in 1819, found a native of the Marquesas ‡ Islands fairly settled among them; and that for many years convicts from the neighbouring penal colonies were continually escaping thence to New Zealand. 5. That from 1820–1840 young New Zealanders were frequently entering whale-ships and other vessels, to serve on cruises in the South Seas, several of whom returned to their native country and settled. 6. That during several years, after the arrival of the missionaries and *before* the formation of the colony, many harbours in New Zealand, and the Bay of Islands in particular, were the common resort of American, Colonial, and other whalers, whose crews were composed of men of many nations and of all colours; and among them were often natives from the East, including China and the South Sea Islands, some of whom settled in New Zealand, and no doubt many of them taught the New Zealander not a few novel things. 7. Two old sayings of the Maoris bearing on this subject I would also adduce:—1. Their terse old proverb, "*He tao rakau ka taea te pare, he tao küekore e taea*"—a wooden spear can be parried,‖ a slanderous word § cannot be parried. Now, if any other more destructive missile were known and in use among them, than the common hand-spear, surely such would have been preferred here. 2. Their saying, on the introduction of fire-arms, and for a long time after, that the only thing they disliked them for was, that by them the warrior fell as well as the slave at a distance,¶ before that the hand-to-hand fight begun:** another proof that deadly missiles acting at a distance were not known. (8) Further, in all their very many proverbs and sayings there is no allusion to any such thing.

My own opinion has long been, that the old New Zealanders (ever quick and able imitators, especially in any matter connected with warfare), having early had lessons from the Tahitian, Tupaea (whom they all but adored) and his son, Taiota, and also on Cook's second voyage from Tahiti to New Zealand, from Mahine, the native of Porapora, in the arts of fashioning and using projectiles, perhaps endeavoured to adopt them, and

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* See appendix B.

† Nicholas' "New Zealand," Vol. I., p. 92.

‡ Cruise's Journal, p. 198.

‖ *Lit.*, a spoken spear.

§ See appendix, note B, for an illustration.

¶ *Lit.*, died like a nobody—a fool.

** The chiefs and the principal men urged onward the rush of the vanguard, but were not in it; they followed.

possibly did so to a certain poor extent; but the great facility with which they very soon acquired firearms caused them to set those missiles aside. What they might have done and perfected, having once been put into the way, had they remained isolated and not obtained muskets, is another matter.

I have been led to make all these almost extra remarks through noticing what was said by a Mr. Grace at the time of the reading of Mr. Phillips' paper, as reported (I am sorry to find) in the "Proceedings" (Vol. X., p. 527). Mr. Grace might equally as well have said, that because *he* had always seen the Maoris playing at draughts, or growing and eating melons, peaches, and potatoes, *ergo*, such were indigenous! Such observations tend to mislead (being wholly erroneous), and will mislead still more in the future unless refuted; hence, in great measure, I now write to such an extent. It is from such superficial remarks that the works of Tylor, Lubbock, and Herbert Spencer, and others, become of less value than they would otherwise be, through everything being gathered and admitted as of *equal* authority!

And just so it is (I regret to say) with some of the remarks made by Mr. Phillips himself in this very paper; *i.e.*, in my estimation they are deceiving, because they assume the very thing we are in search of—"the whence of the Maori?"—a problem by no means yet proved. Yet Mr. Phillips says:—"I have often wondered how it is that the aborigines of New Zealand should have made so little use of the bow and arrow, this being a weapon peculiarly suited to savage tribes, *and, moreover, the familiar one of their ancestors*." (Where did Mr. Phillips get this?) Again, speaking of the toy-arrow he had been describing, he says:—"In itself it is a harmless weapon, and how it happens that the Maoris, a section of the Polynesian race, should have thus allowed so useful a weapon as the South Sea bow and arrow *to degenerate* into a mere toy,* is to me a curious circumstance." (S. Parkinson's remark on this very point, already quoted by me at p. 108, made a hundred years ago, is far more rational *every way*; but then Parkinson, although he had seen more, had no preconception, no pet hobby to support!) Further, Mr. Phillips says:—"It is well-known (?) that in olden days the Maoris *launched their spears* against a hostile fort by means of a whip, similar to the one above described, and they were even able *to hurl stones a long distance*." (Whence, too, is this derived?) Lastly, Mr. Phillips winds up his paper by saying:—"All these weapons, however, fell into disuse after the introduction of fire-arms some sixty years ago, which may account for the *disappearance of the bow and arrow*." To which statement, I trust, this paper will be found a complete answer.

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* *Vide post* "Proceedings H. B. P. Institute, ordinary meeting, September 9, 1878," for an interesting account of the introduction into New Zealand of this "toy arrow," by a living witness.

Mr. Phillips also gives an account of a "pigeon spear," made out of a rough unworked piece of a "*raataa* vine."(!) Just so; that is the poor *modern* spear, hastily put together by the lazy, loquacious, itinerating Maori of modern days! but such make-shifts were not (commonly) used by his forefathers, although I have seen them* stored up in the mountain forests; they were far above it.† And then follows the novel idea of "trapping the brown parrot by means of a shorter hand-spear."(!) As if parrots were ever caught in that way! The Maoris had but one general mode of taking the parrot (*kaakaa*), which was admirably adapted and serviceable, and is still in use in the dense forests of the interior.

My *Note*, referred to at p. 106, is as follows:—"Note 7, par. 15, § 2. —Travelling beyond the East Cape in January, 1838, I arrived at Waipiro (Open Bay), and striking inland over high hills reached a place called Tapatahi, where were the remains of a famous stronghold or *pa* of the olden time. This fort is strongly situated on the abrupt precipitous end of a high hilly yet narrow range, and made impregnable by art; the only possible way of access leading from the top of the ridge, but this the Maoris had completely secured by cutting a deep fosse across it. The Ngatimaru tribe, arriving in their canoes from the North, well armed with muskets for the purpose of slaughter, the people of this neighbourhood took refuge in their stronghold on the crag, where they were regularly besieged. Several hundreds of Maoris were cooped up in it, and for some time the place was closely invested; and though provisions fell short among them there was no outlet of escape. The besiegers getting both tired and *hungry* (!)—for the entrance end of the fort was made so high above the deep-cut fosse that musketry could effect nothing, unless any one of the besieged wilfully exposed himself—at last the besiegers hit upon a mode of attack and assault which proved successful; they prepared sticks with dry combustibles fastened to one of their ends, while to the other was tied a strip of flax-leaf, and the wind being favourable, they set fire to them, and then whirled and flung those flaming darts across the ditch into the *pa*, where, alighting on the dry thatch roofs of the houses and sheds, the whole was soon on fire; then, in the confusion, the assault was made, under cover of their muskets, and the slaughter was very great, even for a successful Maori attack! Many of the unfortunate besieged threw themselves down the precipice in sheer desperation, and only a very small number escaped with their lives. There is a small moat or pool of deep water close to the base of the precipice on one

* That is, a spear-head, fitted on to the rough stem of a large creeper (vine): but never on a *raataa (Metrosideros robusta)*.

† If I mistake not there will be a full description of a "pigeon spear," and how it was made, one of the wondrous works of old! in those *Notes* of mine.

side, and possibly a lucky few might have fallen into it, and so broke the force of their fall. The whole spot is a most romantic one naturally, and at the time of my visit it was desolate and bare—a sad and striking memento of the horrid past !"

The Editor of the "Transactions," in a note of his own appended to Mr. Phillips' paper, refers us to three works, viz. :—

1. Sir G. Grey's "Polynesian Mythology," p. 157. The *single* case there mentioned is said to have taken place in the very *beginning* of Maori history, and was just simply the whirling of a fire-brand on to a thatched roof, much the same as the circumstance above related from my *Notes*.

2. Dr. Thomson's "Story of New Zealand," Vol. I., chap. 7. In this relation (as well as in several other places in his book) there is much of error, as must always be the case with all *modern compilers* who may follow in the Doctor's wake; for (1) Dr. Thomson has completely ignored all that was written by Cook and others,* although he has given a *list* of their works, and the question has often arisen in my mind, did Dr. Thomson ever read them ? (2) Knowing nothing himself personally of the matters in question, he copied freely, and picked up and set down *all* that he heard, too often hastily drawing conclusions. Hence it was that he says of their projectiles—"Occasionally red hot stones were thrown from slings in the hope of setting *pas* on fire ; so were slight javelins, sharp and jagged at the point ; occasionally they were pointed with bone, or the barb of the stingray ; these were discharged by slings from elevated platforms, etc. Bows and arrows were not unknown, though never used in war." (Vol. I., ch. 7.)

3. Mr. White's new work, "Te Rou," is one of fiction, and his long note, referred to by the Editor, is suited to it ; it is of no use here.

Appendix A.—(See p. 109).

Dr. Forster says :—"The weapons which the men of Tanna constantly carry are bows and arrows, clubs, darts, and slings. Their young men are

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* In addition to what we have on record (already referred to) by Cook and others, there are a few *early* celebrated known engagements, attacks on Maori forts by Europeans, when, if ever, the Maoris would have used such projectiles, viz :—(1) That by the French under Crozet, in revenge for the death of their commander (Marion) and his men, when they attacked and took their stronghold or fort in the Bay of Islands. See App. C. (2) That of the combined crews of five whalers on the *pa* in the islet in Whangaroa harbour in revenge for the taking and burning of the "Boyd," and the killing of the captain, passengers, and crew. (3) That of the soldiers and sailors of H.M.S. "Alligator" on the *pa* at W i mate, near Cape Egmont, in revenge for their having plundered Guard's ship, &c. In all these cases the Maori *pas*, or forts, securely fenced and well situated (after the old custom) and almost inaccessible, were attacked and taken; and yet, while the Maoris defended themselves well and long, nothing was seen, or shown, or used, in the shape of "slings" and "hot stones," "bows and arrows, jagged darts, and poisoned *kotahas !*" (*Jam satis !*)

commonly slingers and archers, but those of a more advanced age make use of clubs or darts. The bows are made of the best club-wood *(casuarina)*, very strong and elastic. They polish them very highly, and perhaps rub them with oil from time to time, in order to keep them in repair. Their arrows are of reed, near four feet long. The same black wood which the Mallicollese employ for the point is likewise made use of at Tanna ; but the whole point which is frequently above a foot long, is jagged or bearded on two or three sides. They have likewise arrows with three points, but these are chiefly intended to kill birds and fish. Their slings are made of cocoa-nut fibres, and worn round the arm or waist ; they have a broad part for the reception of the stone, of which the people carry with them several in a leaf. The darts or spears are the third sort of missile weapons at Tanna. They are commonly made of a thin, knotty, and ill-shaped stick, not exceeding half-an-inch in diameter, but nine or ten feet long. At the thickest end they are shaped into a triangular point, six or eight inches long, and on each corner there is a row of eight or ten beards or hooks. These darts they throw with great accuracy, at a short distance, by the help of a piece of plaited cord, four or five inches long, which has a knob at one end, and an eye at the other. They hold the dart between the thumb and forefinger, having previously placed the latter in the eye of the rope, the remaining part of which is slung round the dart, above the hand, and forms a kind of noose round it, serving to guide and confine the dart in its proper direction, when it is once projected. I have seen one of these darts thrown, at the distance of ten or twelve yards, into a stake four inches in diameter, with such violence that the jagged point was forced quite through it. The same thing may be said of their arrows ; at eight or ten yards distance they shoot them very accurately and with great force ; but as they are cautious of breaking their bows, they seldom draw them to the full stretch, and therefore, at twenty-five or thirty yards, their arrows have little effect, and are not to be dreaded."

"The arms of the natives of New Caledonia were clubs, spears, and slings. * * * Their spears are fifteen or twenty feet long, and black. They throw them by the assistance of such short cords, knobbed at one end and looped at the other, as are usual at Tanna, and which seamen call beckets. Those of New Caledonia were of superior workmanship, and contained a quantity of red wool, which we should have taken for the covering of a new sort of animal, if we had not formerly seen the Vampyre or great Indian bat, from whence it was taken. Their last weapons were slings, for bows and arrows were wholly unknown to them. These slings consisted of a slender round cord no thicker than a pack-thread, which had a tassel at one end and a loop at the other end and in the middle. The stones which they used were

oblong and pointed at each end, being made of a soft and unctuous soap-rock *(simectites)*, which could easily be rubbed into that shape. These exactly fitted the loop in the middle of the sling, and were kept in a wallet or pocket of coarse cloth, strongly woven of a kind of grass, which was tied on about the middle. Their shape gives them a striking resemblance to the *glandes plumbeæ* of the Romans."—*Forster's Voyage*, Vol. II., pp. 278, 279, 385.

Appendix B.—(See p. 111).

I here give an interesting extract from "Turnbull's Voyage Round the World" (1801–4), as it bears a little on the subject before us :—

"A chief of note named Te Pahi, with five of his sons, who resided at the Bay of Islands, wished to see Port Jackson. They were taken by Captain Stewart in his ship to Norfolk Island, where they received every attention from the commandant and inhabitants; and after remaining there some time they were received on board H.M.S. 'Buffalo,' to be conveyed to Port Jackson. On their arrival, Te Pahi was introduced by Captain Houstin to His Excellency and the officers at the Government House, where he continued to reside during his stay in the colony.

"Shortly after his arrival, a number of the natives assembled in the vicinity of Sydney for the interment of Carrawaye (whose death was occasioned by a spear wound in the knee), who the night before was conveyed here in a shell composed of strips of bark; and the funeral obsequies being over, a war spectacle ensued, when an intended sacrifice to vengeance (known by the name of Blewit) was singled out to answer for the desperate wound inflicted by him upon young Baker. The animosity of his assailants was uncommonly remarkable; their party was far the more powerful, and, confident of their superiority, took every advantage of their numbers. The flight of spears was seldom less than six, and managed with a precision that seemed to promise certain fatality. After 170 had been thus thrown, ten of the most powerful stationed themselves so as nearly to encircle the culprit, and front and rear darted their weapons at the same instant. His activity and strong presence of mind increased with the danger; five he dexterously caught with his feeble target, and the others he miraculously managed to parry off. One of his friends, enraged at the proceedings, threw a spear, and received ten in return. Blewit turned one of his assailant's spears, and passed it through the body of old Whittaker; the affray then became general, but terminated without further mischief.

"Te Pahi, who with several of his sons was present, regarded their warfare with contempt; he frequently discovered much impatience at the length of intervals between the flights, and by signs exhorted them to dispatch;

he considered the *heelaman*, or shield, an unnecessary appendage, as the hand was sufficient to turn aside and alter the direction of any number of spears. He, nevertheless, highly praised the *woomera*, or throwing-stick, as, from its elasticity, he acknowledged the weapon to receive much additional velocity. He was visibly chagrined when he saw the old man wounded through the body, and would certainly have executed vengeance upon its author, had he not been restrained by the solicitations of the spectators."—*Nicholas' "New Zealand,"* Vol. II., p. 369.

APPENDIX C.—(See p. 114).

M. Crozet's description of this attack is so graphic, and at the same time so much in keeping with what I have known to take place among the New Zealanders in their old sieges, that I am tempted to give an extract, as I believe his work is not commonly known in the colony:—M. Crozet commanded the King's sloop of war, the 'Mascarin,' under M. Marion, and put into the Bay of Islands in distress, having lost his masts. With great difficulty they cut down fit trees, some three or four miles off in the woods, and to get them out had to make a road! They had now been here at anchor thirty-three days, when the Maoris suddenly rose against the French, and killed Marion, with twenty-eight men! and it was with extreme difficulty that Crozet managed to get on board the ship those left on shore. After this the New Zealanders made several attempts to take even the ships, which they fiercely attacked in a hundred large canoes. At last Crozet, seeing it impossible to supply the ships with masts, unless he could drive the natives from the neighbourhood, went to attack their *pa*, which was one of the greatest and strongest. He put the carpenters in front to cut down the palisadoes, behind which the natives stood in great numbers on their fighting stages, from which they threw down stones and darts.* His people drove the natives from these stages by keeping up a regular fire, which did some execution. The carpenters could now approach without danger, and in a few moments cut a breach in the fortification. A chief instantly stepped into it with a long spear in his hand. He was shot dead by Crozet's marksmen, and presently another occupied his place, stepping on the dead body. He likewise fell a victim to his intrepid courage, and in the same manner eight chiefs successively defended the post of honour. The rest, seeing their leaders dead, took flight, and the French pursued and killed numbers of them. M. Crozet offered fifty dollars to any person who should take a New Zealander alive, but this was absolutely impracticable. A soldier seized an old man and began to drag him towards his Captain, but the savage, being unarmed, bit into the fleshy part of the Frenchman's hand,

* As described in Cook's Voyages, Vol. II., p. 342-344.

of which the exquisite pain so enraged him that he ran the New Zealander through with the bayonet. M. Crozet found great quantities of dresses, arms, tools, and raw flax in this *pa*, together with a prodigious store of dried fish and roots. He completed the repairs in his ship without interruption after accomplishing this enterprise, and prosecuted his voyage after a stay of sixty-four days in the Bay of Islands.—*Forster's Voyage*, Vol. II., pp. 461-465.

Art. VII.—*On Temporary and Variable Stars.* By Professor A. W. Bickerton, F.C.S., Associate of the Royal School of Mines, London.

[*Read before the Philosophical Institute of Canterbury, 4th July*, 1878.]

The sudden appearances of stars in various regions of the sky have been recorded from very early dates. Some of these stars have had an intensity of light greater than any of the fixed stars, and in some cases have remained visible for a year or more, the intensity of light all the while gradually diminishing.

Two considerable stars of this kind have appeared within the last twelve years, and in both cases they have been examined with the spectroscope. Unfortunately the results have not been so satisfactory as could be desired. The spectrum of the star of 1866 appears to have been continuous, with bright lines. The lines diminished in number and intensity until they finally disappeared, leaving only a feeble continuous spectrum. The light of the star of 1877 at first appeared yellowish, and when five or six days afterwards it was examined with the spectroscope, a line spectrum was seen. The number of lines gradually lessened until only one was left, and that the same line as is seen in some nebulæ.

A few considerations will show the stupendous nature of these phenomena. Temporary stars have all appeared to be fixed in the heavens, this fact showing them to be at true stellar distances, and consequently, like the fixed stars, their luminosity is comparable to that of our sun. The sun may be roughly classed as a star of the second magnitude ; its intensity is approximately one four-hundredth that of Sirius, which is a very short distance from us relatively to the size of the universe, therefore it is not improbable that these temporary stars should be, on an average, at least as far away as he is.

We may therefore safely assume that most of the temporary stars whose appearance has been recorded, have had an intensity of light as great as the sun, and probably in some cases many times greater. The amount of heat

radiated from each square yard of our sun's surface is estimated to be equal to the combustion of ten cubic yards of coal in every hour, while the sun's disc has four times the area enclosed by the orbit of the moon. The star of 1866 when first seen was of the second magnitude, and its spectrum shows that it consisted of a nucleus of *compressed* gas, or of liquid or of solid matter. This was surrounded by an atmosphere of heated gas, having a greater monochromatic light than the nucleus; or it might have been simply a small permanent star in the same line of vision as the gaseous temporary star. I cannot say if this suggestion agrees with the present condition of the star. This star diminished from a star of the second magnitude to the tenth in about a fortnight. The spectroscope showed the star of 1877 to be ignited gas only, and from the number of the lines diminishing the temperature and pressure probably did so likewise. The intensity diminished in four months from the third magnitude to the ninth.

Many hypotheses have been formed to account for the nature of these stars, of which the following appear to be the most noteworthy:—

1. Zoolner imagines a sun in which spots have covered the whole surface, the temporary stars being produced by the breaking of such a surface.

2. Vogel assumes a volcanic bursting-out on a dead sun.

In both of these hypotheses a decomposition and combustion of hydrogen and other elements is also assumed to account for the great intensity.

3. Meyer and Klein suppose that a similar dark body is suddenly raised to incandescence by the projection of a planet or other body upon its surface.

4. Proctor supposes that the atmosphere of a dead sun is suddenly brought to a high degree of luminosity by the passage of a meteoric train through it.

In examining these hypotheses, we find that there is one thing in common, namely, the assumption of the existence of large dark bodies in space. The first two of them also depend on the existence of internal commotion, attended with combustion. The last two depend upon the energy developed by gravitation.

A little consideration will be sufficient to show that, on grounds of intensity alone, Zoolner's and Vogel's—in fact, any hypothesis not dependent upon gravitation—is improbable. Is it conceivable that a dark body should suddenly change its surface by volcanic or other internal action in such a manner as to heat gases to a pitch of luminosity as high as our sun's, especially when it is considered that if a gas and solid be at the same temperature, the solid is much the more luminous of the two; nor would combustion or decomposition help it; generally the latter would take

place, but would tend to diminish rather than increase the intensity. How inadequate combustion would be is shown by the fact that a pound weight would develope about forty million units of heat in falling upon the sun, and the combustion of a pound of mixed oxygen and hydrogen would only develope about 4000 units. And again, in either case the chief luminosity must be from the fused material; a continuous spectrum would then result, which in the last star at least is altogether contrary to observation. The precipitation of a body upon the surface of a dead sun is much more probable; so likewise is the meteoric theory; but in the former case if sufficient heat could be developed a fused mass would almost certainly result, and in the latter case nothing short of a marvellous combination would prevent its resulting. The latter hypothesis Proctor bases on the bright momentary light once observed on the face of the sun; he assumes that the gaseous photosphere was temporarily raised to a high luminosity by meteors. I think this of itself is very improbable. I cannot conceive how it is possible that if the atmosphere were raised to incandescence it could cool again in so short a time as two minutes. I think it far more probable that that most wonderful phenomenon (affecting as it did the entire earth) was due to the collision of two bodies revolving in approximately opposite directions around the sun. Such a pair of bodies would have their temperature raised to about one hundred million degrees Centigrade. I need not say that such a temperature would quickly volatilize such small bodies and produce an intense light, the phenomenon is in this way explained without any assumption other than known laws. The basis of the meteoric hypothesis is thus shown to be in the highest degree improbable, and even if it were admitted it would require an inconceivable number of meteors to raise the atmosphere of a dark body to such a temperature as to produce a luminosity as great as our sun's and of some months' duration. Still more inconceivable does it appear that the body upon which they impinge should only have its atmosphere raised to such a luminosity, whilst the body itself remained non-luminous. Altogether the theory of Meyer and Klein appears the only possible one, but it is only when both bodies are of such stupendous dimensions as to produce complete volatilization that the hypothesis agrees with spectroscopic observation; and such a case does not appear to be contemplated by the authors or they would scarcely have suggested a planet. Complete dissipation into space could not take place by the entire coalescence of two bodies however large, unless they had a higher initial velocity than observations of the proper motion of stars render probable. No one of these hypotheses, therefore, appears to be a satisfactory explanation of the phenomenon.

An hypothesis that agrees better with observation would be one of partial impact. If two immense bodies moving in space come well within

the influence of each other's gravitation, they would be attracted out of their path with a constantly increasing velocity. Three possibilities present themselves: the first, the most general one, of passing each other and ultimately attaining their original velocity in space; the second would be that of imperfect impact; and third, as an extreme case, we should have complete impact when the centre of each mass would have, except for the collision, occupied the same point at the same time. It is reasonable to assume that in impact the case of partial collision would be more probable than complete impact. And it is this imperfect impact that is the basis of the present hypothesis. In this case a piece will be struck off each colliding body; these two pieces would to a greater or less degree coalesce, developing at the same time a high degree of heat, whilst the remainder of the two bodies would pass on in space. What would finally happen to the two retreating bodies depends on the original proper motion and the masses of the coalesced piece. If the original proper motions were large and the piece cut off small, one or both of the two bodies would most likely pass entirely away from the other bodies and travel on independently in space. If, on the other hand, the original proper motion were small and the piece struck off large, then it would be most probable that they would be once more attracted back and collide again and again until complete coalescence took place; or, as I shall show further, it is possible that they may form a system similar to our solar system. The size of the bodies will also have an influence in the escape or otherwise of the pieces. Other things being equal, the larger the body the greater the probability of escape, as the distance between the centres will be greater and consequently the attraction will be less.

Partial impact appears competent to explain the occurrence of temporary, double, and variable stars, nebulæ of various kinds (the kind depending on the nature of the impact), comets, and finally stars or suns accompanied by bodies of smaller size. The third case, that of complete coalescence, is probable only in the collision of very large bodies, and offers an explanation of the existence of large spherical nebulæ with a general condensation towards the centre. (We will consider the hypotheses somewhat in detail.) In order to render the conception of the hypothesis as simple as possible, I shall all through keep as far as I can to a direct conception of energy, as in this way most questions may be reduced to ordinary arithmetical series. Thus, if the two approaching bodies be equal to each other (at the same distance), the attracting force acting on each unit of mass will be proportional to the total mass of either; now in a force acting through space, the work equals the force multiplied by the space through which it acts, and the work is equal to the heat.

The sun, by attracting a body from infinite space, would give it a velocity of 378 miles a second, or each unit of mass would develope about forty million units of heat. If we suppose two bodies, each half the size of the sun, to come together by mutual attraction alone, then each unit of mass would develope about twenty million units of heat. If, on the other hand, two bodies twice the mass of the sun come together, each unit of mass would have four times the force acting upon it through equal spaces, and each unit of mass would consequently develope four times as much heat. If the impact of such bodies were imperfect, as we have seen the general case would be, a piece of each would be cut off, and these two pieces would coalesce. Suppose a quarter of each be struck off, a body of the mass of the sun would be produced, but it would have four times the temperature the sun would have, assuming the sun to have been formed by direct impact and complete coalescence. Each unit of mass in this case would have approximately eighty million units of heat; and the temperature will depend upon the specific heat of the material, and may be much higher than this.

I will now show, in the case of partial collision, how small relatively the work of cutting off the piece is compared to the energy available. It appears to me that in all cases the energy needed for shearing force has its superior limit in the latent heat of fusion. This, in the case of ice, is about one-fiftieth that of combustion, and combustion is about one twenty-thousandth part that of percussion, in the case we have been considering. The work of shearing would consequently not be greater than one millionth that of the energy of velocity, and so it appears it may safely be disregarded. Thus in the case of such a partial collision it may certainly be accepted that those parts not in the line of motion of the other body will not coalesce with the other body, but will pass on in space. In the piece struck off we shall have partial destruction of motion in space, with development of heat; many pieces will fly off, and a rotary motion of the whole will ensue. There will be a slight pause from inertia, then the powerful outward pressure due to the expansion by heat will overcome all resistance, and will expand the whole into gas, much of it certainly passing beyond the limits of effective attraction, and away into distant space. Let us pause for an instant to examine a little more fully what has happened.

Two pieces of different bodies, each with a velocity of about 500 miles a second, have coalesced, but although the motion of translation is destroyed the larger part of each side of the mass is made up chiefly of one of the two different bodies: as these are moving in opposite directions, there is consequently a couple acting on the mass, and this couple spins the mass on its centre. Consequently many pieces fly off, and are followed by the mass of gas, being impelled outward by the energy of heat and centrifugal force;

whilst, on the other hand, we have inertia and gravity tending to keep the mass together. The centrifugal force acts only in one plane, whilst the repellent force of heat acts in every plane; a bun-shaped mass must result, with a number of distinct pieces, which at first at least are in advance of the general mass. Follow it on in time and we get the ring nebulæ, with or without a luminous centre; in the latter case, with a dark circle dividing those parts whose velocity has carried them beyond the powers of the attractive force, from those parts held prisoner by it. These parts, as they gradually radiate heat into space, are once more slowly attracted to the centre by gravitation. If the piece struck off from each body were very small, then complete dissipation of the whole into space would result. Clearly such collisions as I have described would be competent to produce every variety of temporary stars that has appeared. Applying the spectroscope to such a star, we get at first a continuous spectrum; then black lines, quickly followed by bright lines and spectrum; then bright lines alone. Again, if the colliding bodies were of very different size, or if the heat were not great enough to entirely volatilize the star, we should have lines and spectrum. Lastly, as heat and pressure diminish by the dissipation of the body into space, we get fewer and fewer lines, until only those substances in greatest quantity, or of greatest power in giving lines at lowest temperature and pressure, remain luminous, and we have a nebulæ left; or in the case of total dissipation of the gaseous mass all evidence of its existence will disappear. It will be seen how exactly the above hypothesis agrees with the spectroscopic observation of temporary stars; and I have shown as fully as perhaps it is wise to do in this paper, that the hypothesis of partial impact is competent to account for every variety of these bodies, and also for their intensity and short duration.

We must now return to the parent bodies which we left travelling on in space. A cylindrical or curved slice has been cut out of each; sometimes that is the chief thing that will happen. But on the other hand we may have the molten interior of the body exposed to view. If there were atmospheres on the two colliding bodies, a very great heating of the surface of the section would result, and when both causes are acting in unison a stupendous lake of fire must be formed. Let such a body rotate on its axis, alternately the light and dark sides are shown, and we get a variable star. May not Mira in this way be attempting to tell us her autobiography; how she is a dark body, with a molten lake of fire, 30 degrees of arc, a lake as big as our sun, and how she rotates about an axis in a little less than a year? If it be so, she tells us of a dark body almost as large as Sirius, or how would 30 degrees of arc produce a star of the first magnitude? Algol appears to tell us that it is a dark and gloomy parent, with a brilliant son who periodically passes

partly behind his dusky parent's body, and in this way suffers partial eclipse.

But the autobiographies of these bodies must not detain us; we must discuss the existence of such gigantic feebly-luminous or non-luminous bodies as our hypothesis demands. The existence of variable stars seems sufficient to prove there are such bodies, and, as I have shown, all the hypotheses offered in explanation of temporary stars assume their existence. The high temperature and small relative light of celestial radiation points to the same conclusion, or to non-luminous gas. It might be asked, if there are dark bodies, why not stellar eclipse. I do not know if such have been observed; it would be wonderful if any had been, for they must be very rare, probably as rare as temporary stars; for, although we have all the depths of space in which eclipses are possible, on the other hand with temporary stars we have attraction bringing very distant bodies together. Further, the points of light of the fixed stars form but a small area in space, and, lastly, if eclipses occurred they would probably not be recorded, as small black patches of cloud so often obscure a portion of the sky that such an occurrence would scarcely attract attention. But why should there not be large dark bodies? Laplace's theory of a universal nebulæ may be assumed to be against it; but did Laplace assume that it was contemporaneous? if not, then even that theory does not interfere. All our conceptions seem to agree more with a rhythmic cycle than with any definite beginning or end. If we assume this hypothesis, then the period of dissipation of energy seems indefinitely projected into futurity; for all radiation falling on the matter in space, must prevent its temperature from falling so low as without this radiation, and when at a subsequent date a collision occurs, this heat must exalt the final temperature. Nor does it appear that we need look forward to a gigantic dead sun as the final condition of this universe; for doubtless our universe has its own proper motion in space, which may bring us into collision with other universes. This shows that gravitation may be as competent to multiply worlds as to absorb them one into another. But after all our hypothesis only takes us a step back in time, and our imaginations a step forward into the future, thus removing further than ever from our conceptions every trace of a beginning or promise of an end.

Art. VIII.—*Partial Impact: a possible Explanation of the Origin of the Solar System, Comets, and other Phenomena of the Universe.* By Professor A. W. Bickerton, F.C.S., Associate Royal School of Mines, London.

[*Read before the Philosophical Institute of Canterbury, 1st August*, 1878.]

In the last paper which I submitted to the Institute, I gave a short sketch of some hypothetical cases of partial collisions, and suggested that such cases might possibly be of frequent occurrence throughout space, and might offer an explanation of many phenomena of the universe. I especially showed the application of the hypothesis to temporary and variable stars. To-night I intend to show that it appears competent to explain the formation of the solar system, of comets, of meteors, and of some variety of nebulæ. I shall, however, in the first place point out the very great difference which exists in the capabilities of cases of *partial* and *complete* collision, the first offering a field of possibilities of cosmical phenomena which is really surprising, the latter being probably confined to but a few rare cases.

In the last paper I *assumed* that the partial collision of two attracting bodies having an original proper motion in space, would be much more likely than entire coalescence. It appeared, however, to be a very general idea, that if the bodies struck at all, it must be that their mutual attraction would certainly produce complete coalescence. On the other hand, it was generally admitted that two bodies when attracted by each other would seldom come into contact, but would in most cases be carried by their original velocity away once more from each other's influence. It is only necessary to assume that the size of the bodies has increased enormously without increase of mass for a case of mere disturbance to become one of partial collision; the generality of the case is thus practically demonstrated. As cases of partial collisions may be of infinite variety, for the sake of simplicity I have in this paper (except where stated to the contrary) assumed that all the colliding bodies are of the same size; composed of the same chemical elements; with the same initial proper motions, the velocity of which is small compared with that developed by attraction; also that the mass of each of the two bodies of any one pair is the same.

If two bodies come into direct collision from rest, a definite energy of velocity will be acquired at the moment of contact, depending solely on the mass. After coalescence, if a single particle were attracted from infinite space, the particle being attracted by the whole coalesced mass, and this mass not appreciably moving towards the particle, twice the force would act through twice the space, and would develope twice the velocity, or four times the energy. Hence, also, a particle to leave the body must have this double velocity. Therefore, as it does not appear reasonable to expect that

after collision any portion will acquire much greater energy than before, we may reasonably assume that no part will acquire four times the energy of motion, and be thrown off into space. On the other hand, if two bodies come into partial collision, a piece of each would coalesce, and the rest would pass on into space. If the motion be entirely destroyed, the temperature developed by coalescence will be the same, no matter what proportion be struck off; whilst, if the pieces struck off be very small, the coalesced mass will have but little attractive power to keep the body together, and hence the velocity of each particle may be great enough to project the whole into space; whereas we have seen, in the case of complete coalescence, none would be able to be thus projected. This is a most important distinction between partial and complete collision.

Influence of Chemical Composition.

If two bodies, each a mixture of chemical elements, meet and destroy their motion of translation, then a molecular motion of identically the same energy must be developed (a small part will be converted into some form of potential energy, but this we will disregard). If a mass of small bodies have the same energy as an equal single mass, the velocity is also equal. Whence we must also assume that the velocity of the molecules, no matter what may be their respective weights, is not greater than the velocity of the whole body was before impact. Therefore, from what has been stated, in direct impact no particle will have sufficient velocity to leave the mass *immediately* after impact. But different elements having the same velocity are at different temperatures, inversely proportional to their molecular weight; the heavy atoms are therefore very much hotter than the light ones. We know by the laws of heat that these unequal temperatures will tend to equality; but it is worth while looking at this a little in detail. Let us suppose a hydrogen and a mercury particle to meet. The mercury is one hundred times as heavy as hydrogen, but the velocity of both is the same. The collision cannot produce heat, as it is heat motion already. The principle of energy at once tells us that the mercury will lose a part of its velocity, and the velocity of the hydrogen will be increased. Let this happen many times, and the temperature will become equal; in other words, the hydrogen will be moving ten times as fast as the mercury. Let both of these particles come to the surface of the body; their molecular motion will cause them to leave it; the hydrogen will probably have velocity sufficient to carry it away from effective attraction, which is impossible with the mercury, as initially its velocity was insufficient, and now it is less than before. Thus we see that at the surface of a mixed gaseous atmosphere there is a tendency the opposite to that of the diffusion of gases; probably the hydrogen and lighter atomic weight elements will be on the out-

side, and the heavier on the inside of bodies. Hence, the chief elements of the surface of bodies may reasonably be expected to be hydrogen, lithium, carbon, nitrogen, oxygen, magnesium, sodium, and sulphur. All these elements, except lithium (which may consequently be assumed to be universally rare), are the common elements of the surface of bodies; and hydrogen, the highest of all known bodies, is the most common of all. Is not the element of 1474 line, which is found outside of hydrogen on the sun, an element of still less atomic weight than hydrogen? If this hypothesis be true, then it is reasonable to assume that diffused hydrogen must fill space. This would account for the retardation of comets and planets without the assumption of an ether resistance. It thus appears that the molecular motion of gases may become one of mere translation. There is accordingly a continuity of heat and mechanical motion. It is reasonable to suppose, that at a certain height above the sun the general motion of the particles of hydrogen may become more or less parallel; there would be no collisions of molecules, and consequently no luminosity would be then produced, and an apparent dissipation of the protuberances would occur. I have now shown the most striking points in the contrast of the energy of different cases of collision. I have also shown a possible reason why the small atomic weight elements are common on the surface of bodies; why we should expect to find hydrogen on the surface of all bodies, such as the sun and stars; lastly, that hydrogen, and probably the unknown element of the sun, may be the resisting substance which retards the motion of bodies in space.

On the Rotation of Systems.

It does not seem reasonable to expect rapid rotation in the case of entire coalescence of two bodies, as only the resultant of the two original rotations will tend to develope this motion. But, in the case of partial collision, we must have a rapid rotation of the mass, as each of the two bodies from which it was formed occupy chiefly one side of the new body, and as the velocity of each of the two bodies was originally opposite to that of the other, rotation is a necessary consequence.

There are two chief reasons for the inequality of the balance of momentum at the two sides of the coalesced mass: 1st. The piece cut off will be much thicker towards the middle of the original mass than at the outside. 2nd. The density of the inside is much greater than that of the outside, in consequence of the greater pressure, and also from the fact that it is probable the heavier elements are towards the centre of the mass. It may easily be seen that the resultant momentum on the two opposite sides are in opposite directions, consequently tending to rotation.

Comets and Solar System.

It is almost certain that the initially irregular shape of the two coalesced pieces would cause many smaller masses to fly off into space, producing possible visitants to other worlds, but in most cases the heat would be sufficient to cause all these masses to be converted into gas.

When two bodies of different size attract each other, the velocity acquired by the smaller body will be greater than that of the larger one (as an apple falling to the earth does not give the earth the same velocity as the apple itself acquires). With unequal bodies therefore, when collision occurs, the larger piece will have a smaller velocity than the smaller, hence there will be two orders of fragments. First, from the small piece, the high velocity of which may make comets and shooting stars of them.

Planets.

Secondly, the fragments of the larger piece, whose small velocity may not take these bodies away from effective attraction, and they may thus become planets.

But the large mass of our sun shows that if the planets of our system have been formed in this way, one of two things must have occurred, either the original proper motion of the bodies must have been very much greater than the average is at present, or the bodies themselves must have been very large, so that even at impact the centres were a long distance from each other. There is, however, another reason why at impact the centres may have been at a distance from each other—namely, the great distortion of the bodies which must take place immediately before impact, in consequence of their mutual attraction. It is impossible to give even an approximate idea of how much this may influence the result. Generally, it is easy to see that the problems offered by partial impact are of extreme difficulty, the data being of necessity of infinite variety.

It is shown further on, that there is another partial impact hypothesis which may possibly explain the origin of our system.

All the following remarks apply equally to that hypothesis :—

At first the orbits of these bodies would be extraordinarily eccentric; on passing away on this first journey they would be in advance of the expelled gas, but would meet it on returning. This would tend to neutralise the force of attraction, and the orbit would become much more circular. Again, the passage of the planet through the gas would retard it. And lastly, on each of its orbits the attraction of gravitation would be greater on its outward journey than on its return, in consequence of the expelled matter passing outside its orbit into space. This fact would both tend to render the orbit more circular, and also tend to neutralise the action of the gaseous resistance in causing the body to approach the sun. It

is a well-known fact, that if a projectile revolves on one axis at right angles to the line of motion, there is a tendency to move in a curve. (The full discussion of this phenomenon would occupy much time.) It is possible to show that this force at first would have considerable effect in rendering the orbits circular, but finally with the planets near the sun its effect may be to render the orbits more elliptical. All these forces, therefore, tend to render the orbits more circular, but not as an average result to alter their mean distance from the sun. The larger masses would suffer less resistance in proportion than the smaller ones, and the general result would be, that if all started at the same distance the smaller bodies would be brought nearer the sun. It is easy to see that the centrifugal force and the attraction of nebulous mass would cause all the planets to travel approximately in the plane of the ecliptic, also why the sun's equator so nearly approaches it, and generally, why the rotations of the planets on their axes should be in the same direction. On the other hand, the pressure due to heat, the extreme want of symmetry of such a case of partial impact, combined with the original motion of rotation of the colliding bodies, if they had any, must all tell in the ultimate resultant motion, both orbital and axial. Almost certainly these forces would produce slightly inclined orbital planes, inclination of polar axes to these planes, and may as an extreme case produce a retrograde motion. It is also easy to see that the enormous atmospheres of those early days would effectually clear the bodies of all but very large masses of cosmical dust.

The Asteroids.

This fact appears of itself sufficient to show that the production of the asteroids must have been a subsequent event to the formation of the solar system. With respect to the asteroids, it is conceivable that the destruction of the planet which formed them may have been produced by a large meteoric visitant, with a high velocity. This hypothesis shows that such bodies may exist in considerable numbers. Such a mass might conceivably bury itself in another body, and when its motion of mass was stopped, its heat might be sufficient to produce a pressure of many thousand atmospheres. Such an explosion of developed gas might reasonably be expected to blow the body to pieces. It is generally considered that if the asteroids had been produced by the destruction of a planet, the fragments would have the same mean distance from the sun, and would pass the same points in their orbits where the destruction occurred; which is contrary to the observed motions of these bodies. The hypothesis that they are pieces of a planet is therefore not generally accepted; but these assumptions are only true if the velocity remain the same, the eccentricity of the orbit the same, and there is no resisting atmosphere. The first of these assumptions is

clearly not admissible in such a case as I have suggested, and the relative positions of the planets would influence the second. Or if this be considered to be insufficient, it is only necessary to assume that the destruction took place before the whole of the gas had been absorbed by the sun. Altogether, I think from the great eccentricity of the orbits of these bodies, from their positions, from the varying inclinations of the planes of their several ecliptics, from their varying intensity, and their small size, the only conceivable explanation of their formation is by a violent explosion. This would account for all their peculiarities. I am unacquainted with any force in nature that could produce such an explosion except the one here suggested.

Saturn's Rings.

It would appear also that the rings of Saturn cannot be considered to be a primary phenomenon; they may have been developed by the blowing to pieces of a moon, or by Saturn's atmosphere entrapping a train of meteors. This latter suggestion hardly appears so reasonable as the former. If the destroyed moon was brought to a very high temperature, mere liquid spray might have been produced, which would quickly cool and become a mass of solid particles revolving around in all eccentricities.

Comets and Meteors.

It is a necessity of this hypothesis that there should be large numbers of bodies travelling in space. Groups of these bodies may frequently have a common direction. Of these bodies it is probable that some may be very large, and even come within the solar system, yet remain invisible except as meteors. But it is conceivable that in some cases of collision bodies may leave, consisting chiefly of carbonic acid; which at certain stages of a body's heat, may form an important part of its atmosphere. It is not difficult to imagine that a portion of the atmosphere of such a body may have taken a common direction in space, and in its path become attracted by our system. If its nucleus, when near the sun, were volatilized carbon, and its atmosphere carbonic acid, the result of the sun's radiation on such an athermic substance as carbonic acid might certainly decompose it. Might it not be the case that the temperature of dissociation of carbonic acid may be lower than the temperature of the volatilization of carbon? There are certain peculiarities in the electric light supporting this. Thus the carbon might be liberated as a sublimate away from the sun, but in the direction towards the sun, the temperature may be sufficiently high to volatilize the carbon. This, or some other radiation theory, as Tyndall has suggested, seems the only one possible to explain the stupendous velocity of the growth of the tails, amounting in some cases to as much as 5,000 miles a second, a velocity which the energy of the sun would be incompetent to give to matter. Again,

this hypothesis agrees with some of the spectroscopic observations of comets, in which the tail gave a feebly continuous spectrum, showing it to be solid, and the nucleus a banded spectrum, showing it to be gaseous. It may be possible that there are other gases whose temperature of decomposition is lower than the temperature of volatilization of one of their constituents, such as fluoride of silicon and generally halogen compounds of infusible bases.

The Sun.

I shall now attempt to show that there may be agencies at work which may cause a great difference of temperature between the poles of the sun and its equator. This may give us an insight into the cause of the tremendous cyclones of the meeting solar trades, and these cyclones are possibly the cause of such spots. If this hypothesis really represents the formation of the solar system, then it is probable that radiation is greater in a direction perpendicular to the ecliptic than in its plane. Again, the combined energy of gravitation and centrifugal force would cause most of the absorbed matter to fall upon the sun about the equator; both of these causes may produce a great difference of temperature between the poles and the equator of the sun, sufficient, perhaps, to produce cyclonic spots. The projection of bodies upon the surface of the sun, bodies trapped by the sun itself, might probably produce the sea of flame which surrounds it, and the protuberances so often seen upon its limbs. The precipitation of bodies upon its surface appears to me to offer the only conceivable explanation of the high velocity which the hydrogen on the surface of the sun sometimes possesses. The speed of some comets proves that bodies in space may have a velocity of many hundred miles per second, and we know that a body at rest would acquire nearly 400 miles a second by the sun's attraction alone. Therefore many bodies may fall upon the sun with a velocity of 500 miles a second or more. Such a body would bury itself far down in the sun, clearing the gas by pressing it down before it and in a few minutes it would be many thousand miles into the sun, and, its motion of mass destroyed, a temperature of 100,000,000 might readily be developed, which, even if the density of the body were no higher than air, would amount to a pressure of 400,000 atmospheres, and would most likely be much greater than this. Here are all the conditions for a most powerful explosion, amply sufficient for all that has been observed of the prominences. It is quite evident that if there are trains of bodies, which have been brought into the orbits around the sun, most of the phenomena of periodical variations of spots and protuberances may be explained on the assumption that these bodies plunge obliquely into the body of the sun.

On Double and Multiple Stars.

When the original proper motion is small, and the proportions struck off large, after partial coalescence the greatly increased attraction acting on

the two retreating bodies will in many cases cause one or both of them to be attracted back to the coalesced mass; but as the force which produces this return is partially due to the other retreating body, and for reasons already mentioned, the returning body will not necessarily come into collision with the coalesced mass, but may revolve around it producing double stars, or, if both bodies returned, triple stars, and in many cases the coalesced mass would also separate and produce even quadruple, or still higher multiple stars. I need not say that many thousands of multiple stars exist. Generally the returning stars, although sometimes of greater magnitude, would be of less luminosity, but this body would collect much of the matter revolving around the more luminous body, and so have its own temperature raised. In the case of nearly complete collision, the two pieces leaving the coalesced mass might reasonably be expected to break into pieces. It is possible to show that the rotation of each of these pieces must generally be in the same direction as the rotation of the coalesced mass, and that most of the forces acting would tend to produce a system resembling the solar system.

Nebulæ.

I have already shown how a ring nebulæ may be produced by a case of partial collision. The cometic nebulæ would be produced when a high resultant velocity was produced in the coalesced mass. It is not difficult to conceive that in the collisions of approximately equal bodies the coalesced mass might separate chiefly into two other larger masses, and produce double nebulæ, and ultimately double stars revolving around each other. Again, a case of almost complete coalescence appears competent to give rise to the conditions we observe in the spiral nebulæ, as it will be seen that rotation will be very slow in this case, and the expulsion of matter irregular, although it must be confessed that it seems probable that generally a large nucleus of continuous nebulæ would be produced. At the same time possibly higher power observations may show this to be the case.

Art. IX.—*On the Calculation of Distances by means of Reciprocal Vertical Angles.* By C. W. Adams.

[Read before the Philosophical Institute of Canterbury, 12th September, 1878.]

The distance between any two points on the earth's surface may be found, if the angle subtended by those points at the centre of the earth is known,

as it is then only necessary to multiply the number of units in the given angle by the value of one unit at the earth's surface, in order to find the distance, or "Contained Arc," as it is generally called.

The method of deducing the subtended angle, or rather the length of the "Contained Arc," when the vertical angle from each station to the other is given, may be shown as follows, dividing the problem into two cases—first, when one angle is an elevation; and, secondly, when both are depressions.

CASE 1.—*When one angle is an elevation, and the other a depression.*

Fig. 1.

To investigate a method of ascertaining distances by means of reciprocal vertical angles:—Let A and B in fig. 1 represent the two stations, and C the centre of the earth. Draw $A\ F$ a horizontal line at A, and $B\ G$ a horizontal line at B, and $B\ H$ parallel to $A\ F$. Then $A\ B\ G$ is the true angle of depression at B, and $B\ A\ F$ is the true angle of elevation at A, and $G\ B\ A - H\ B\ A$ (or $B\ A\ F$) $= C$ (the contained arc). Thus we see that the difference between the true angles of elevation and depression is equal to the "contained arc," and taking the mean value of $1''$ on the earth's surface = 101·4 feet or 153·6 links, we could thus obtain the distance between the two stations in feet or links.

But the observed angles are not the true angles, as they are both affected with refraction.

Let $A\ K$ and $B\ K$ represent the apparent direction of each station from the other.

Let D represent the true angle of depression, $G\ B\ A$.

Let E represent the true angle of elevation $B\ A\ F$.

Let C represent the angle $A\ C\ B$ or contained arc; and

Let R represent the angle of refraction $= K\ A\ B$ or $K\ B\ A$.

$G\ B\ K$ will be the apparent angle of depression $= D - R$.

And $K\ A\ F$ will be the apparent angle of elevation $= E + R$, and the difference between the observed angles of depression and elevation will be $(D - R) - (E + R) = D - E - 2R = C - 2R$.

Now, assuming R to be $\frac{1}{15}$ of the contained arc, $C - 2R$ will be $C - \frac{2}{15}C = \frac{13}{15}C$.

Therefore the difference between the observed angles of elevation and depression will be $\frac{13}{15}C$; so, by multiplying the number of seconds in $\frac{13}{15}C$ by $\frac{15}{13} \times 153{\cdot}6$, we shall get the number of links in the contained arc, or the distance between A and B. (Note $\frac{15}{13} \times 153{\cdot}6 = 177{\cdot}3$). If the distance between A and B is required in feet instead of links, then multiply by $\frac{15}{13} \times 101{\cdot}4 = 117$.

CASE 2.—*When both angles are depressions.*

Using the same notation as before, except that D and d represent the true angles of depression, and $D - R$, $d - R$ the observed angles of depression; then $D + d + F = 2$ right angles, also $C + F = 2$ right angles $\therefore D + d = C$; and $D - R + d - R = C - 2R$. That is, the sum of both angles of depression $= C - 2R = C - \frac{2}{15} C = \frac{13}{15} C$, and $\frac{13}{15} C \times \frac{15}{13} \times 153{\cdot}6$ (or sum of observed depressions in seconds multiplied by 177·3) = distance in links between A and B. If the distance between A and B is required in feet, then multiply by 117 instead of 177·3.

The above results expressed in words give the following

Practical Rule.

Take the sum of the observed vertical angles when both are depressions; or their difference when one is an elevation, and reduce this sum or difference to seconds; multiply by 177·3, and the result will be the approximate distance between the two stations in links. NOTE.—If the distance be required in feet, then multiply by 117.

Or the following general rule will apply to all cases:—Subtract 180° from the observed *zenith distances*, reduce the remainder to seconds, and multiply by 177·3, the result will be the approximate distance between the two stations in links.

In the preceding investigation, I have assumed the mean value of 1″ on the earth's surface = 101·4 feet, and I shall now show what is the greatest error that can be introduced in any case by this assumption.

The radius of curvature on the meridian varies with the latitude from a minimum at the Equator $\left(= \frac{P^2}{E}\right)$ to a maximum at the Pole $\left(\frac{E^2}{P}\right)$.

And the radius of curvature of the Prime Vertical also varies with the latitude from a minimum at the Equator (= E.) to a maximum at the Pole $\left(= \frac{E^2}{P}\right)$.

Also, the radius of curvature in any latitude varies with the Azimuth from a minimum on the meridian to a maximum on the prime vertical.

Still the limits of variation are so small, compared with the ordinary errors of observation, that in general practice it is sufficient to assume 101·4 feet as the mean value of 1″ on the surface of the earth for New Zealand.

The following are the precise values for latitudes 39° and 44°, taking 39° as the mean latitude of the North Island of New Zealand, and 44° as the mean latitude of the South Island.

		Feet.
Taking Bessel's value of the equatorial radius (E)	=	20923597
And Bessel's value of the polar semi-axis (P)	=	20853654
The value of 1″ on the meridian at lat. 39°	=	101·164
The value of 1″ on the prime vertical at lat. 39°	=	101·575
∴ The mean value of 1″ at all azimuths in lat. 39°	=	101·370
Again, the value of 1″ on the meridian at lat. 44°	=	101·252
And the value of 1″ on the prime vertical at lat. 44°	=	101·604
∴ The mean value of 1″ at all azimuths at lat. 44°	=	101·428
And the mean value of 1″ at all azimuths at lat. 39°	=	101·370
∴ The mean value of 1″ at all azimuths for both Islands of N.Z.	=	101·399
Or say, 101·4 feet.		

It will thus be seen that, by using this mean value, the results would be sometimes slightly in excess of the true values, and sometimes slightly in defect; but in any case the difference would only amount to about $\frac{1}{5}$ per cent., and may therefore in ordinary practice be neglected.

With regard to the co-efficient of refraction which I have adopted, it may be thought that $\frac{1}{15}$ is too small, as in most works on surveying it is stated to be from $\frac{1}{13}$ to $\frac{1}{14}$.

The reason I have used $\frac{1}{15}$ is because I find it more in accordance with actual observations in hilly country in New Zealand.

The factor 177·3, as stated above, is obtained by taking the value of 1″ on the earth's surface as 153·6 links, and the refraction as $\frac{1}{15}$ of the contained arc; but if it is required to obtain the distance in any other denomination, such as feet, metres, miles, etc., for any other values of terrestrial curvature and refraction, this may easily be done by means of the following formula:—

Let v = value of 1″ on the earth's surface, in the given denomination

,, m = co-efficient of refraction

,, F = the factor required;– then

$$F = \frac{v}{1-2m}$$

Example. Suppose $v = 30{\cdot}89$ metres and $m = {\cdot}071$

then $\frac{v}{1-2m} = \frac{30{\cdot}89}{{\cdot}858} = 36$, the factor required.

It must be borne in mind that this method is only approximate, as the observed vertical angles are liable to an error of 2″ or 3″ even when an 8-inch theodolite is used, and a mean of several observations taken.

Supposing the average error of each double observation to be 5″ or 6″ then the error in the calculated distance would be 5 or 6 times 177 links, say about 10 chains. This would be 1 per cent. in a distance of 1000 chains, which is the usual distance between geodesical stations in New Zealand.

The chief advantage of this method is that the observations are not subject to a ratio of error in proportion to the distance. Most approximate methods, by telemeters, etc., although tolerably correct for short distances, fail altogether when applied to long distances; but this method gives pro-

portionately better results, the longer the distance, as I estimate it as subject to an average error of 5″ or 6″ which is equivalent to about 10 chains, and this error is the same for all distances. Thus, in finding the distance between two hills 50 miles apart, this would only introduce an error of 2½ links per 10 chains, thus nearly approaching in accuracy to a chained measurement, besides being free from accidental errors and omissions which all chained measurements are liable to.

But although the errors of observation do not affect the results in proportion to the distance, still, any error in the estimated refraction will do so; therefore this method is only suitable for hilly country, where other methods are not available; as, whenever the line of sight between the two stations passes for any considerable distance close to the surface of water or level land, the refraction is generally very variable and uncertain, and the results obtained by this method will then be unreliable.

In my own practice, using an 8-inch transit theodolite, reading to 10″, and noting the level readings at each observation, the distances found by this method have an average error of half-a-chain to the mile.

For instance, in a circuit of 50 miles between two known points, average distance of stations 10 miles apart, the error was found to be 23 chains, or less than half-a-chain per mile. In another case, there was an error of 31 chains in 60 miles, or about half-a-chain per mile.

It is requisite, in this method, to use only the *corrected* vertical angles, that is, they must be corrected for the height of the eye and object.

Rules for calculating the correction are given in most books on surveying, but the following blank form will be convenient when the difference of heights of the eye and object is given in feet and inches, and the distance between the stations in links:—

Blank Form.

Difference of height of eye and object in *inches*	log	. · . . . . .
Distance between stations in *links*	colog	. · . . . . .
Colog tang 1″—log 7·92 = constant	log	4 · 4 1 5 7 0
Correction in seconds of arc =	log	. · . . . . .

Note.—When the height of the eye exceeds the height of the object, the correction is to be added to an elevation or subtracted from a depression.

When the height of the object exceeds the height of the eye, the correction is to be added to a depression, or subtracted from an elevation;

Or the rule for applying the corrections may be simplified thus:

Mark angles of elevation + mark angles of depression.
Mark height of eye + mark height of object.

Then take the algebraical sum of the heights of the eye and object, to compute the correction, to which prefix the same sign; then the algebraical sum of this correction, and the observed vertical angle, will give the true vertical angle.

In order to compute this correction by the above rules, the distance between the stations is required to be known; but as in all cases where this method is used the distance between the stations is not known, we must proceed as follows:—

With the observed vertical angles, as they stand in the field-book, compute the distance between the stations; and with this approximate distance, compute the eye and object correction. Then, with the corrected angles, again compute the distance, and in most cases no further calculation will be required; but in cases where the second calculation gives a result differing greatly from the first approximation, it may be advisable to repeat the calculation.

Instead, however, of neglecting the eye and object correction altogether, in calculating the first approximation, it will be sometimes advantageous to ascertain the correction roughly, and take it into account. This may be done as follows:—

As 1 inch subtends 1″ at 26044 links or 3¼ miles nearly, we can easily ascertain the angle subtended by any number of inches, at any number of miles distance, by the following rule:—

Multiply the inches by 3¼ and divide the product by the number of miles, the quotient will be the number of seconds subtended. The distance in miles can generally be estimated to within 10 per cent. or so, and calculating the first approximate correction in this way will often save time.

Example.

Bryant's Hill to Barker's Hill. Elev. 1° 14 13″
Barker's Hill to Bryant's Hill. Dep. 1° 22′ 50″

		Ft.	In.		In.
Bryant's Hill to Barker's Hill.	Height of eye =	3	1		
	" object =	0	0		
	Eye exceeds object	3	1	=	37
					3¼
	Distance, say 10 miles			10)	120
					12·0″

		Ft.	In.		In.
Barker's Hill to Bryant's Hill.	Height of eye =	2	4		
	" object =		7		
	Eye exceeds object =	1	9	=	21
					3¼
				10)	68
					6·8″

Bryant's Hill to Barker's Hill. Elev., 1° 14′ 13″ + 12″ = 1° 14′ 25″
Barker's Hill to Bryant's Hill. Dep., 1° 22′ 50″ − 6·″8 = 1 22 43·2

8 18·2 = 498″·2
3771
49820
34874
3487
To compute the eye and object corrections 149

Inches.			
37	=	log	1·56820
88330	=	colog	5·05389
		constant log	4·41570
Correction	10·″9	= log.	1.·03779

Inches.			
21	=	log	1·32222
88330	=	colog	5·05389
		constant log	4·41570
Correcttion	6·″2	= log	0·79181

Corrected Angles.

Elev. 1° 14′ 13″ + 10″.9 = 1° 14′ 23″·9
Dep. 1° 22′ 50″ − 6· 2 = 1 22 43· 8

8 19· 9 = 499·9
3771

49990
34993
3499
150

∴ Distance from Bryant's Hill to Barker's Hill = 88632 links
True distance as found by Triangulation = 89197 „

Difference 565 „

Which is about half a chain per mile.

Having found the contained arc, or distance between the stations, in links, by the rules given above, the difference in altitude may be obtained in the usual way, viz., by converting the links into feet and then multiplying the distance in feet between the stations by the tangent of the true angle of elevation or depression. (Note.—The true angle of elevation or depression is half the sum of the observed reciprocal angles, when one is an elevation; or half the difference when both are depressions; or, generally, if zenith distances are used, the true vertical angle is equal to half the difference of the reciprocal zenith distances;—of course supposing the eye and object corrections to have been applied.)

But instead of finding the distance between the stations in links, and then converting it into feet, it would be more simple to find the distance in feet at once, by using the factor 117 instead of 177·3, as before explained:—

Example.

Bryant's Hill to Barker's Hill. Corrected Elev. 1° 14′ 23″·9
Barker's Hill to Bryant's Hill. „ Dep. 1° 22′ 43″·8

Diff. 8′ 19″·9 = 499·9

Sum. 2° 37 07″·7

½ Sum. 1° 18′ 33″·8

499·9	=	log	2·698883
117	=	constant log	2·068186
1° 18′ 33″·8	=	tangent	8·359040
1337·0 feet	=		3·126109

If no logarithmic or trigonometrical tables are at hand, the difference of altitude may be found as follows :—

As ·00000485 represents the value of sin 1″ arc 1″ or tang 1″ (true to the last figure), and as the tangents of small angles vary very nearly as the number of seconds contained in the angle, we may substitute for the tangent of the angle the number of seconds multipled by ·00000485.

In practice, the operation may be shortened by combining the two multipliers together ; thus, ·00000485 × 117 = ·0005675.

(NOTE.—In order to show how very nearly the sines, arcs, and tangents agree for the first two degrees, their values at two degrees are given, for the sake of comparison.

			Diff.
Thus sin 2°	=	·0348995	71 = 1½″
arc 2°	=	·0349066	
tang 2°	=	·0349208	142 = 3″

Therefore, the arc of 2° = sin 2° 00′ 01½″, and the tangent of 2° = arc of 2° 00′ 03″.

Also, in obtaining the tangent of 2° by multiplying ·00000485 × 60 × 60 × 2, the result is ·0349200, or just ⅙ of a second below the true value.

Similarly the tangent of 1°, found in the same manner, is ·0174600, or just 1″ above its true value ; but the value used for tang 1″, viz., ·00000485, is slightly in excess of its true value, which is ·000004848l368, etc.)

Then the difference of altitude may be found by the following rules :—

CASE 1.—*When one angle is in an elevation.*

RULE.—Take the difference of the observed vertical angles, and also half the sum, both reduced to seconds ; multiply them together, and their product by ·0005675 ; the result will be the difference of altitude between the two stations in feet.

CASE 2.—*When both angles are depressions.*

RULE.—Take the sum of the observed verticle angles, and also half the difference, both reduced to seconds, multiply them together, and their product by ·0005675 ; the result will be the difference of altitude between the two stations in feet.

Or, if zenith distances are used, the following general rule will apply in all cases :—

RULE.—Subtract 180° from the sum of the observed zenith distances and reduce the remainder to seconds ; then take half the difference of the observed zenith distances and reduce it to seconds ; multiply the two quantities together, and the product by ·0005675, and the result will be the difference of altitude between the two stations in feet.

Example as before.

½ Sum. =	1° 18′ 33″·8 =		4713·8		
Diff. =	8′ 19″·9 = 499·9		9994	=	499·9 reversed
			18855		
			4242		
			424		
			42		
			2356300		
	·0005675		5765000	=	0005675 reversed
			11782		
			1414		
			165		
			12		
	Diff. of altitude	=	1337·3		feet

Even when a book of logarithms is available, the calculation by logs will be more expeditiously performed by using the logs of the above quantities than by using the log tangent.

Example.

1° 18′ 33″ ·8	=	4713·8	log	3·673371
8′ 19″ ·9	=	499·9	log	2·698883
Constant log ·0005675		=		6·753966
		1337·3 feet	=	3·126220

With regard to the actual results obtained by this method, I may mention that in the circuit of 50 miles previously referred to, the altitudes closed to 18 feet, and in the circuit of 60 miles, the error in closing was only 2 feet.

It is thus evident that this method is quite capable of giving reliable results in hilly country, and is well adapted for the topographical survey of a new country. A line of stations might be selected in the most accessible positions, and each line used as a base from which to extend triangles on either side, and as every line is determined independently, there would be no accumulation of error.

On the contrary, by observing to distant hills on either side, the distances found would check each other, and any erroneous result could be rejected.

In very level country, where the refraction is too uncertain to give reliable results by this method, other methods may be employed, such as chained lines, or triangulation from a measured base, etc.

Art. X.—*A Description of inexpensive Apparatus for measuring the Angles of Position and Distances of Double Stars, and the Method of using it.*

By James H. Pope.

Plate I.

[*Read before the Otago Institute, 13th August, 1878.*]

Undoubtedly anyone who wishes to make observations of double stars should provide himself with a first-class telescope equatorially mounted, having an aperture of from eight to ten inches; he should place this telescope in a commodious and well built observatory and should procure a first-class filar micrometer and a galvanic chronograph. He should have perfect illuminating apparatus, so that the micrometer wires may appear as bright lines on a dark field or as dark lines on a bright field, and he should be able at will to employ whatever tint he wishes to give to his field or his wires. Besides all this, his telescope should be accurately driven by clock-work, so that he may keep a star in one part of the field of view as long as he wishes to do so, and may have both hands at perfect liberty to take angles of position and to measure the distances between the components of double stars. But, unfortunately, this apparatus is extremely expensive. Cooke of York will provide every requisite for some £1200; it is not every one that can quite see his way to spend such a sum. There are many enthusiastic students of astronomy who are anxious to engage in this kind of work, but think it quite out of their power to do so on account of these same pecuniary difficulties. The following paper attempts to show how good work in this department of astronomy may be done at a very trifling expense, and to make it evident that the possessor of a good telescope may, with a small expenditure of trouble and a still smaller expenditure of money, hope to be in a position to take measures of double stars, that will be worth preserving in the scientific records of the day. Here I would say, once for all, that the methods described in this paper are, many of them, not new. Some of them were invented by Sir John Herschell, some by other astronomers. For many of the details the writer alone is responsible. For working out the mechanical construction, and for many most valuable improvements in the water-clock used in the method, the writer has to thank Mr. Forsyth, station-master, Caversham. All that the writer claims to have done is to have worked out a complete system (the materials for which have been derived from various sources), by means of which double star observation is placed within the reach of a large class of students of the starry heavens, who are debarred from pursuing this fascinating branch of astronomy by the great expense involved in procuring the instruments ordinarily used in it.

Fig. 1 represents the field of view of a positive eye-piece of high magnifying power. In this are arranged, in the manner shown in the figure, images of wires for ordinary use and of webs for more delicate observations.

Fig. 2 is the position circle. This is made of very stout block-tin, and is wired at the back to prevent its warping. Its circumference is divided into degrees (the minutes are to be estimated). The circle is fastened on a central cap, like that which is used for a sun-shade, so that the circle can be screwed on to the eye-piece with facility. Every care must be taken to set the plane of the circle at right angles to the axis of the telescope.

Before the circle is put on the eye-piece, the index I, fig. 3, is placed on the telescope, tube T″, and temporarily secured by means of the clamp and screw Cs. Then the circle is put on, and the apparatus will be in the condition represented in fig. 3. If the telescope used is equatorially mounted and properly adjusted, it may be now turned on a double star in any part of the heavens ; if it is an alt. azimuth, a star must be chosen on or near the meridian, the nearer the better. The star, or rather one of the component stars, is now made tò run along between the wires TT, fig. 1, by turning the eye-piece tube of the telescope round until it does so. Then the index I, fig. 3, must be made to point accurately to the zero of the position circle, and be firmly secured there by means of the clamp.

Next the eye-piece tube is turned round until the line joining the centres of the two stars is exactly parallel to the two wires. Then the circle indication is read off, and, if necessary, 180° must be added to the angle so obtained. Then, evidently, the angle of position with the meridian has been obtained. Several observations of the same star on different nights should be taken. It is advantageous, too, to use different parts of the circle as the zero point. If this be done, the mean of all the observations will be a very close approximation to the truth.

Having found the angle of position, we next proceed to obtain the distance. This operation should be attempted only in the very finest weather. The writer always measures distances either in morning or evening twilight, or in full moonlight when the moon is near the meridian. Thus the illumination difficulty is avoided.

The clepsydra, the use and construction of which will easily be understood from the section of it given in fig. 4, is placed in a convenient position near the telescope. The tanks T and T″ are filled with water, the eyepiece tube is turned round as in the previous operation. until one of the components of the double star runs along the wire TT or the web w.w. Then the star is recalled and raised in the field a litttle, so that it may transit the oblique wire TW, or the oblique web w.T. The instant that the first star is bisected by the wire or web, the lever is pressed sharply down to the peg P

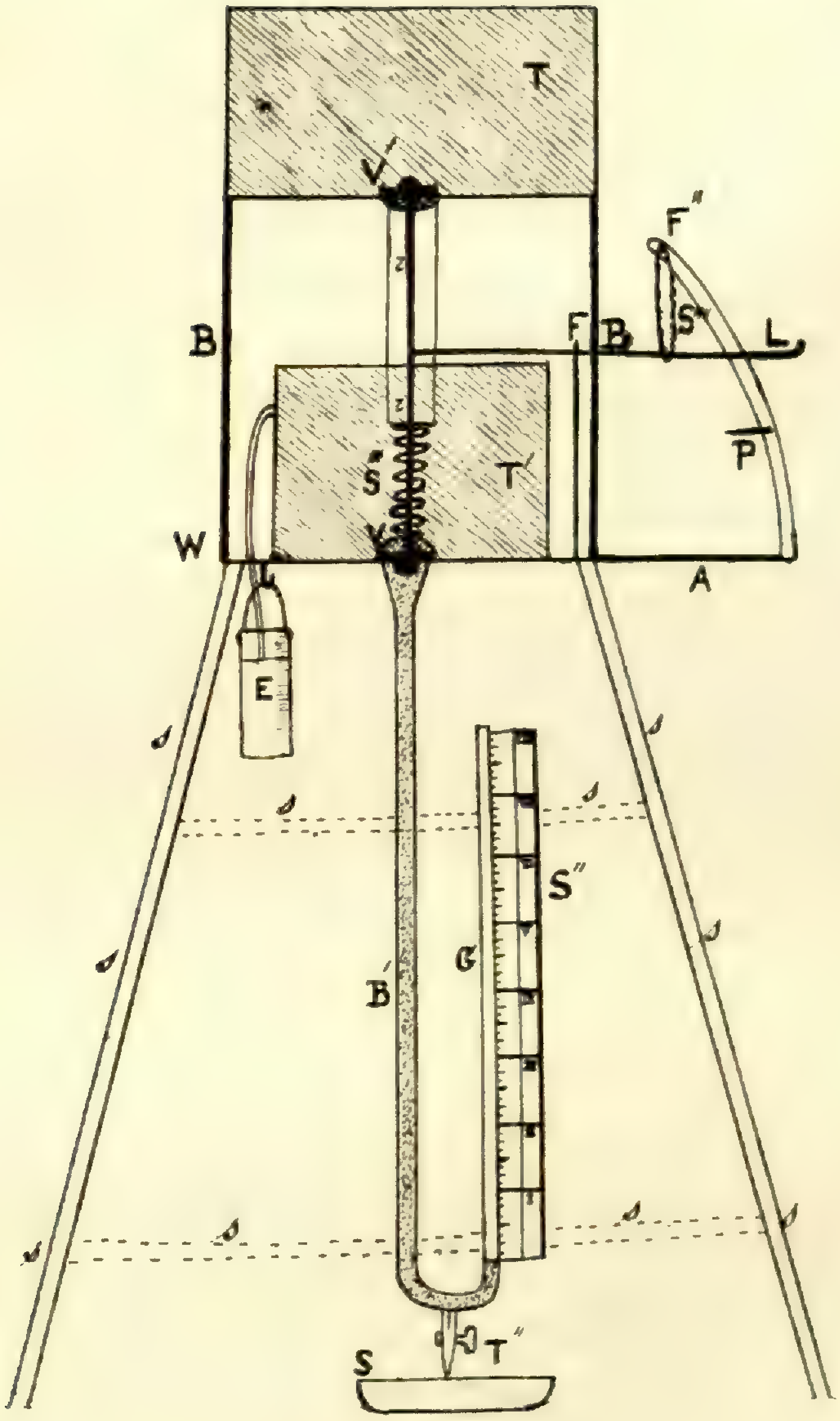


Fig. 4.

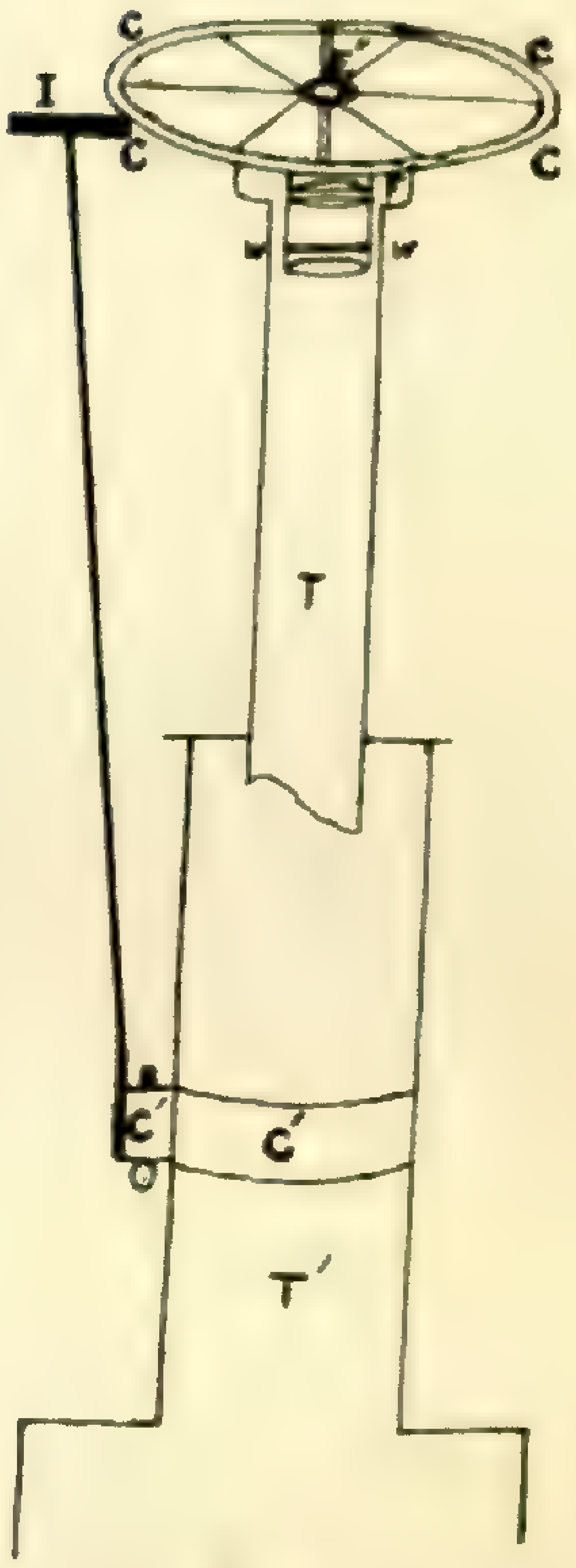


Fig. 3.

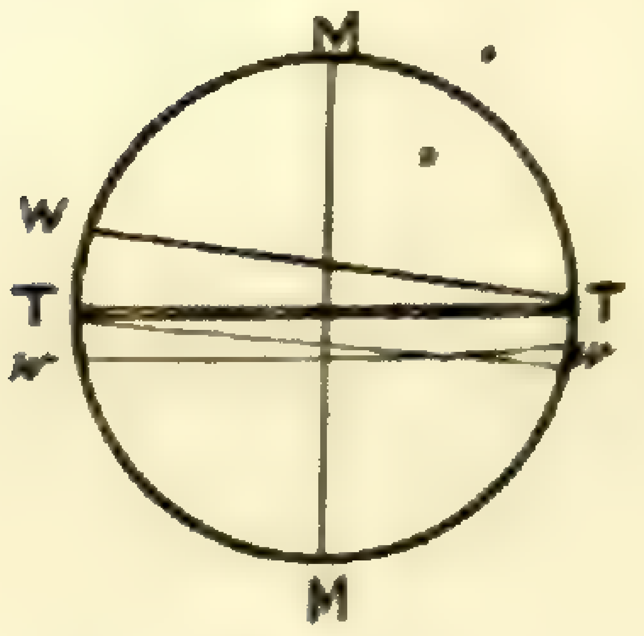


Fig. 1.

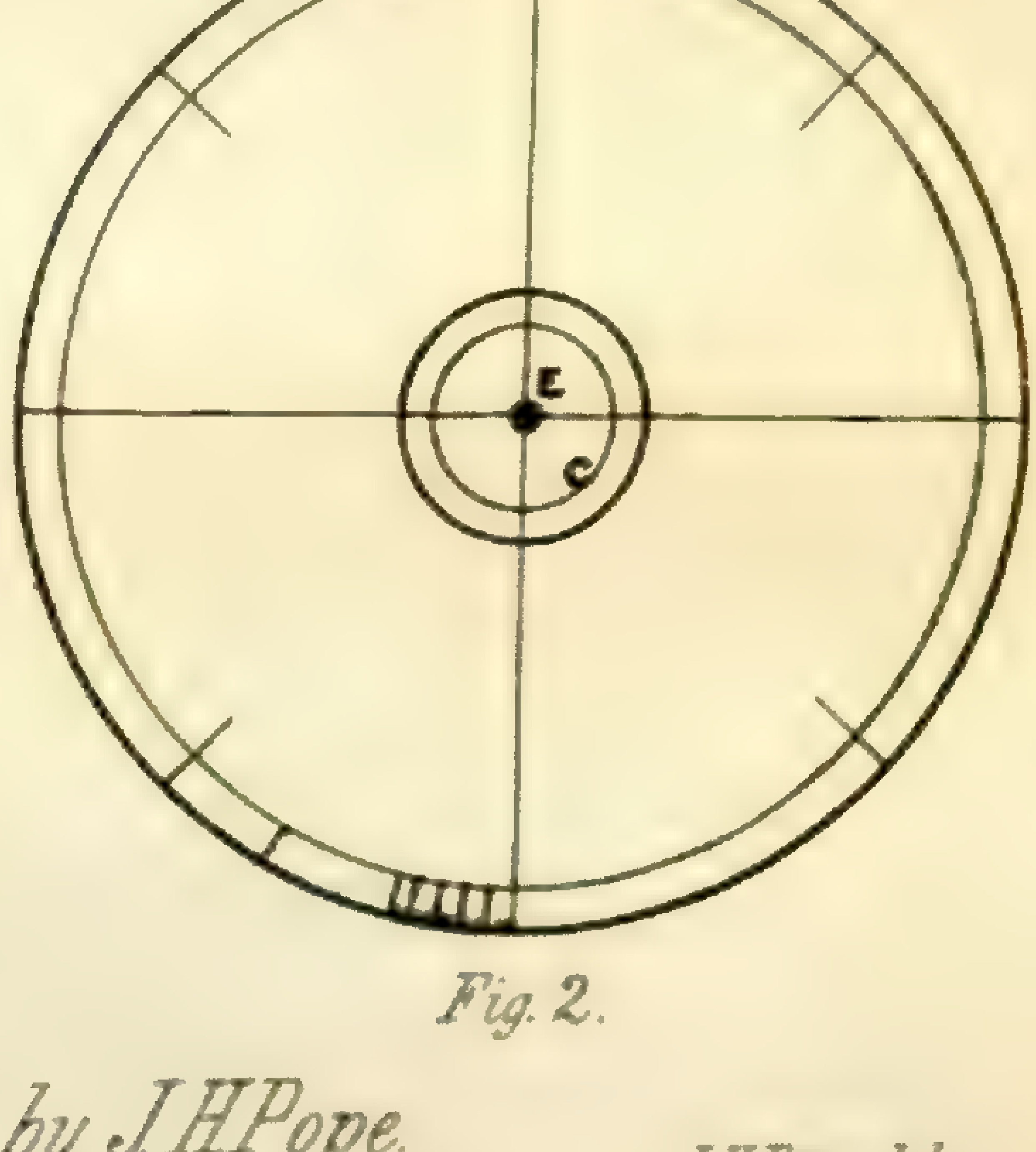


Fig. 2.

To illustrate paper by J. H. Pope.

J. H. Pope, del.

EXPLANATION OF PLATE I.

ROUGH PLANS OF POSITION CIRCLE, ETC.

Fig. I.—Field of Oblique Transit Eye-piece.

M M	Meridian transit wire.
T T	Declination parallel wire.
w w	Declination parallel web.
T W	20° oblique transit wire.
T w	10° oblique transit web.

Fig. II.—Position Circle.

E Eye-hole.

C Cap for fastening circle to tube of telescope.

Fig. III.—Vertical Section.

C	Position circle.
E	Eye lens.
w w	Wires.
F	Field lens.
T	Eye-piece tube.
T′	Telescope tube.
C′	Clamp and screw for index.
I	Index.

ROUGH SECTION OF CLEPSYDRA.

Fig. IV.

T	Upper tank.
T′	Lower tank.
V′	Upper valve.
V	Lower valve.
l l	Brass rods connecting valves.
B′	Brass pipe.
G	Glass pipe.
T″	Waste tap.
S	Waste saucer.
E	Excess bucket.
S″	Graduated scale.
B	Bars, supports.
L	Lever.
F	Fulcrum.
S‴	Spring.
P	Peg to limit movement of lever.
F″	Fastening of spring.
A	Iron arm.
W	Waste pipe.
s s s	Stand.
S‴	Spring to keep valve shut.

and firmly held there, this raises the valves VV′, and water flows up the glass tube G, which has previously been filled up to the zero point of the scale. The instant that the second star is bisected by the wire or web the lever is released, the valves are immediately closed, and the flow of water ceases. The height of the column of water is then accurately measured by means of the graduated scale. Then the water is allowed to escape through the waste-tap T″, and the operation is repeated. A mean of all the observations gives the quantity of water that flows into the glass-tube during the interval between the transits of the two stars. Let this quantity be 2·25 inches. Then an observation is made, by means of a watch, of the time required to fill the tube, that is to say for 30 inches of water to run into it; let this time be 21·5 seconds. A rule of three sum shows us the time elapsing between the transits of the two stars:—

inches.		inches.		secs.		secs.
30	:	2·25	: :	21·5	:	1·612

1·612 seconds of time is, therefore, the interval between the transits of the two stars.

Having found this interval, a simple trigonometrical calculation gives us the distance between the two stars:—

Let p = the North Polar distance of the star.
a = angle of position of the wire; and
θ = angle of position of the line joining the stars.
T = interval between the two transits in seconds of time.
Δ = distance in seconds of arc between the two stars.

$$\text{Then } \Delta = \frac{T \times 15 \,.\, \sin p \,.\, \cos a}{\sin (a - \theta)}.$$

These calculations are not very troublesome. A very little practice enables one to do them very rapidly. It may be as well, in conclusion, to give an example just to show how very little labour is really involved in this process.

On April 5th, 1876, twelve oblique transits were taken of the star 4763 (of Brisbane's catalogue), R.A. 14h. 0m., Decl. 53° 6′ S. The average duration of time between the transits of the component stars of the double over a wire inclined 78° 5′ to the meridian, was 9·61 secs. The angle of position had been found to be 22° 0′. Then—

9·61 secs. × 15 = 144·15	Log	2·158814
sin p (36° 54′)		9·778455
cos a 78° 5′		9·314897
cosec $(a-\theta)$ 56° 5′		10·081000
		1·333166

The natural number corresponding to this is 21·53. Hence the distance between the stars is 21½ seconds of arc. This measure was taken before apparatus described in this paper had been made as perfect as it is at

present. It is probable that measures taken now with the improved position circle and the clepsydra, will at all events approach in accuracy the best measures taken with perfect appliances. If mercury could be used instead of water with similar apparatus, still better results would be obtained, but as the object has been to incur as little expense as possible, it has been thought advisable to adapt the arrangements to the use of water.

It is obvious that this method is available for measuring the diameter of planets, sun-spots, etc., and also for selenographical observations.

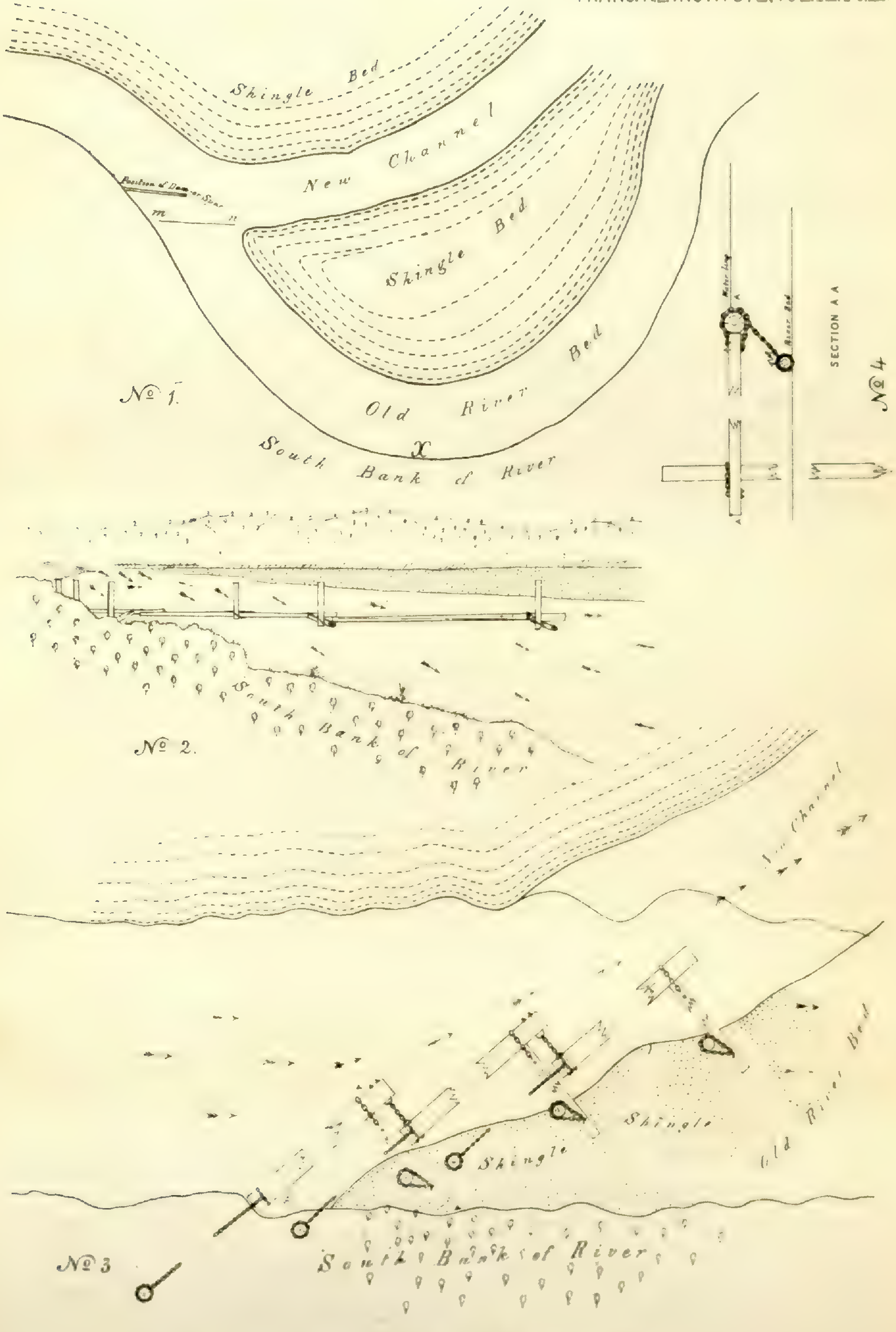
Art. XI.—*Deflection of Shingle-bearing Currents and Protection of River Banks by Druslin's Floating Log Dams.* By H. P. Macklin.

Plate II.

[*Read before the Wellington Philosophical Society*, 17*th August*, 1878.]

The plain of the Wairau in the Province of Marlborough is a tract of flat alluvial country, averaging about ten miles by seventy, and has been formed on the channel of an ancient iceberg (mer-de-glace), by the streams from the surrounding hills and the Wairau River, which traverses its entire length, rising on Mount Mackay, and debouching in Cloudy Bay, a portion of Cook Strait. Geologically the plain is of post-pliocene formation, surrounded towards the north and west by mountains of metamorphic and palæozoic origin, and on the south by low hills of marine tertiary drift.

The Wairau River has evidently formed the greater portion of the plain, and carries with it immense quantities of shingle, of which it is made the receptacle, by the rivulets from the hills. The district is a prosperous farming one; and from its first settlement, has been liable to considerable damage, not only from the flood-water itself, but also from the shifting of the river-bed, and the deposit of shingle on the adjacent lands. The town of Blenheim is situated on the middle of the plain, and unfortunately, its site is lower by several feet than the surrounding country. Every year its danger is becoming more imminent, as the beds of the river and its branch, the Opawa, are gradually rising, from these rivers being compelled to deposit the drift on their banks and beds by lateral embankments. The late Provincial Government, under the direction of eminent engineers, has tried in vain many devices to direct the stream from the town. All were unavailing, as the rapidity of the current undermined cratings, tanks, and wing-walls, while the enormous quantities of shingle deposited defied all control. Not a wreck remains of all the works thus erected, costing some £15,000. On plan *No. 1* will be seen, at the point *X*, the lowest point in the river bank, whence the town gets flooded by overflow, and where the



To illustrate paper by H.P. Macklin.

river threatens to form a new channel, leading directly through the town, as the lowest portion of the plain. The construction called a "dam" was erected some two years ago, at the point Z, (plan No. 1) and has not only diverted the stream into the "new" channel, but raised the bank of shingle behind and below it. The old bed is gradually silting up. Had solid planking been put in to divert the current, it would have got undermined almost immediately, and the shingle been carried on and deposited where it would do harm.

The theorem is as follows:—If a current will carry shingle, when travelling at the rate of six or seven miles per hour, but will not, if the velocity is decreased to say four, then, anything so decreasing it, will force it to drop the shingle; and, what is of more importance, at the point where it is so decreased. The invention I have to describe was suggested to Mr. Druslin, by observing and experimenting on the action of one log floating and moored diagonally across a current, by which it was seen that the surface current was deflected. It then became clear that a series of logs moored at certain distances from the bottom above one another, and so fixed to upright posts that they would float or rise with the flood, would not only divert the current by producing a resultant between the downward velocity and the resistance, but by forming eddies below the logs, and decreasing the velocity, cause the deposit of all the shingle. The water here in flood time is about twelve feet deep, and there is a series of frameworks of five logs each, averaging twenty-eight inches in diameter, placed diagonally across the stream, sloping from the bank at an angle of 135 degrees down stream. It will be seen that these logs, fixed in the following manner, check about half the volume of current and divert the remainder.

Piles of very heavy timber are driven into the bed of the river; the first horizontal log lies on the bottom, the next about a foot above it, and so on to the surface; the whole series is so arranged that the top log always floats; in fact the structure is so buoyed that it rises on the piers with the flood. The accompanying plans will show the construction. Reference to plan No. 3 will show how the stones and sand get piled up during a flood, so high as to reach within a short distance of the surface, while in front of the logs there is a raging torrent. There is one defect about this invention, which led many people to condemn it at first. During flood-time a bank of shingle is raised, averaging eight feet (see along the line $m\ n$ on plan No. 1), but during its subsidence, and until the next flood occurs, the river is acting on it, and cutting it away. But plans are now devised for placing a wing-wall of planks, perpendicularly to the horizon, in a frame in such a manner that they will drop into any holes made beneath them by the water, thus keeping the bank of shingle intact. There is no doubt in my mind

that the town of Blenheim has been saved by this invention. Of all the money spent in conservation and attempts to divert the stream, these log-dams only remain, and when thrown up shingle can be retained, no danger need be feared for the future. It will thus be seen that the great problem of how to divert the current and make a bank of shingle where it can be utilised, has been solved in one of the most dangerous and rapid rivers in New Zealand. Unfortunately the conservation of rivers here is in the hands of a Board elected by the settlers from among themselves, and such bodies are not only slow to see, but timid in admitting the merits of a new idea. To make the matter clearer than can be done by written description I forward a small model of the invention.

Art. XII.—*On Beach Protection.* By W. D. Campbell, Ass. Inst. C.E. Plate III.

[*Read before the Westland Institute, 15th July*, 1878.]

The encroachments of the sea on the sandy ridge upon which a portion of the town of Hokitika is built, have often been very considerable during tempestuous weather, and at times have created no unusual amount of alarm among the inhabitants of Revell Street. The subject of beach protection will therefore be of interest and importance to many present, and I propose to briefly discuss it, prefacing my remarks by a glance at the conditions presented by waves in accumulating and removing beaches.

The movements of shingle and sand along the coast are due to the waves, whose direction is determined by the prevailing wind, but tidal currents sometimes indirectly affect their action by subduing or increasing the waves according as they may be with or against their direction. The action of the waves may be taken to be of three kinds:*—1st. The accumulative action, which heaps up the particles against the shore. 2nd. The destructive action, which breaks down the accumulations previously made. 3rd. The progressive action, which carries forward the pebbles and sand in a horizontal direction.

The difference between the first and second actions is determined by the rate of succession of the waves; for when they break upon the shore so rapidly as to over-ride each other, a continuous downward under-current is produced and the destructive action commences. The progressive action takes place when the waves impinge obliquely upon the shore.

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* See "Observations on the Motions of Shingle Beaches," by H. R. Palmer, C.E., F.R.S., Phil. Trans. Royal Society, 1834, Part I.

Works, having for their object the protection of the sea-beach, should divide the destructive and progressive actions of the waves. This requirement is fulfilled by piled and planked groynes, constructed at right angles to the shore line, their tendency being to collect and retain the sand and shingle. When the waves approach the shore exactly at right angles, the groynes will have their minimum effect, as no progressive action exists. The constant shifting of the beach, however, at Hokitika, either to the north or south, shows that an oblique direction usually prevails. Groynes have been found to be most successful in similar cases of encroachment on the coasts of Great Britain. In the Baltic, a double row of piles has been found to succeed; while on the Dutch coast groynes are constructed of fascines, where the dykes are more than usually exposed to the waves. The English practice is to drive the piles from one-half to two-thirds of their length in the sand or shingle, either in pairs, placing planking between them, or to have a pile on alternate sides of the planking. Sheet-piling would be particularly advantageous, and is shown in figs. 1 and 2, which closely resembles a design by Mr. R. Pickwell, A.I.C.E. With main piles 27 feet long, and sheet piles 15 feet long, the rate per yard run would be 15 lin. feet main piles, 3 CBM timber in planking, sheet piles, and waling, 51lbs. ironwork in bolts and 30lbs. in shoes. With planking only, the quantity per yard run would be 15 lin. feet main piles, 1 CBM timber in planking and 40lbs. ironwork in bolts and 8lbs. in shoes.

To protect the beach from opposite Camp Street to Hampden Street, a distance of 770 yards, six groynes, each 66 lin. yards in length, might be placed every 154 yards. Their cost would be about £3,000. With the foreshore thus protected a line of scrub and saplings could be placed with advantage along the beach. The cost would be about £500.

As instances of the successful conservation of foreshores by groynes, it may be mentioned that, at Spurn Point in Yorkshire,* piled and planked groynes were used by Sir John Coode, and in four years the line of bent grass had extended 200 feet to seaward, covering many drift banks; also at Withernsea,† in the same neighbourhood, some groynes 300 to 350 feet long were constructed 200 yards apart by Mr. Pickwell; the piles at first stood ten feet above the beach at the land end and six feet at the sea end, the upper five planks were added as the beach accumulated, and in four years the groynes were nearly covered; at Eastbourne and Folkestone groynes of similar construction have been successfully used; at the former place they were constructed 150 yards apart, the piles were driven in pairs with two walings and a centre row of closely driven sheet-piles six inches

* Proc. Inst. C.E., Vol. XXVIII., p. 503.

† Proc. Inst. C.E., Vol. LI., p. 206.

thick. At Cranz, on the Baltic, rows of piles 8 x 8 inches and 10 to 12 feet long, spaced 18 inches apart, have been successful, with a breastwork of piles and fascines. Breastworks are often required in cases of low foreshore or where a cliff is exposed to rapid erosion by the sea.

Beaches have also been successfully formed along the sea barriers of reclamation works by means of groynes. At Sunderland, successive additions were made to the reclaimed area as the beach formed. In 1874-5 the author had charge of similar works at Ayr; a reclamation of 24 acres of foreshore for a dock was made, and six groynes with stone filling, each 150 feet in length and 250 feet apart (see figs. 3 and 4), were constructed along the line of sea barrier in order to collect a beach in front of it. In the first year after their erection a rise of two to three feet took place. With main piles, having a nett length of 31 lin. feet, the rate per yard run with scrub and stone filling, instead of wholly stone as shown in the drawing, would be $18\frac{6}{10}$ lin. feet main piles, $2\frac{3}{4}$ CBM timber in way-balks, walings, cross-ties, and planking, and 50 lbs. iron work in bolts, $3\frac{3}{4}$ lbs. spikes and 21 lbs. in shoes; scrub and stone filling $17\frac{1}{3}$ cubic yards. The cost of 6 groynes, each 66 lin. yards, would be about £5,300.

On spits and low beaches exposed to encroachment, groynes require to be constructed first, and then rows of fascines and scrub can be placed with advantage along the crest of the beach. The scrub placed along the beach at Hokitika probably assisted the accumulation of sand behind it; but without groynes it cannot affect the action of the sea at the foot of the beach where the erosion is greatest, and encroachment proceeds until the scrub is undermined. The rough cribwork groynes that Mr. Rochfort placed on the beach in 1867 and 1868* were efforts in the right direction, but a much greater length would be required for efficient protection. The formation of a broad beach upon which the waves can expend their force is of far greater importance than a high narrow ridge which must always be liable to be washed down by heavy seas.

The fetch or reach of open sea is considerably greater here than at those places that I have mentioned, and the waves from that cause must be larger; but the depth of water off Hokitika at $\frac{1}{2}$ mile and 1 mile distance is 26 and 42 feet, at Sunderland it is 27 and 52 feet; while the range of spring tides at Hokitika is 9 feet, and at Sunderland it is 14 feet 6 inches; and it must follow that the power of the waves are more broken here, having to pass over shallower water. I believe the design shown in figs. 1 and 2 would be efficacious, and it has the merit of presenting the minimum amount of surface to the seas.

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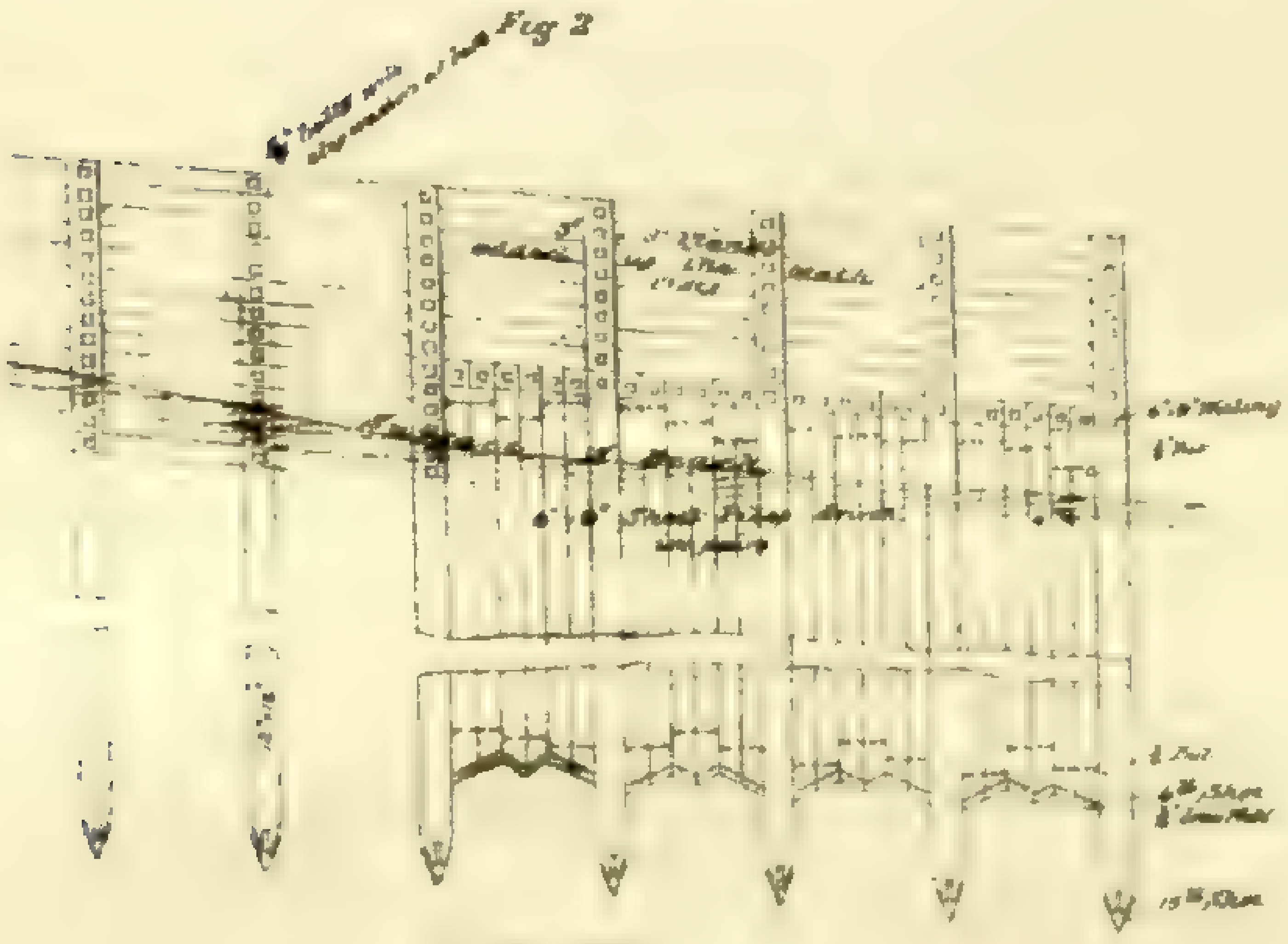
* See Trans. N.Z. Inst., 1871, Vol. IV., p. 299.

Fig. 1.

PLAN

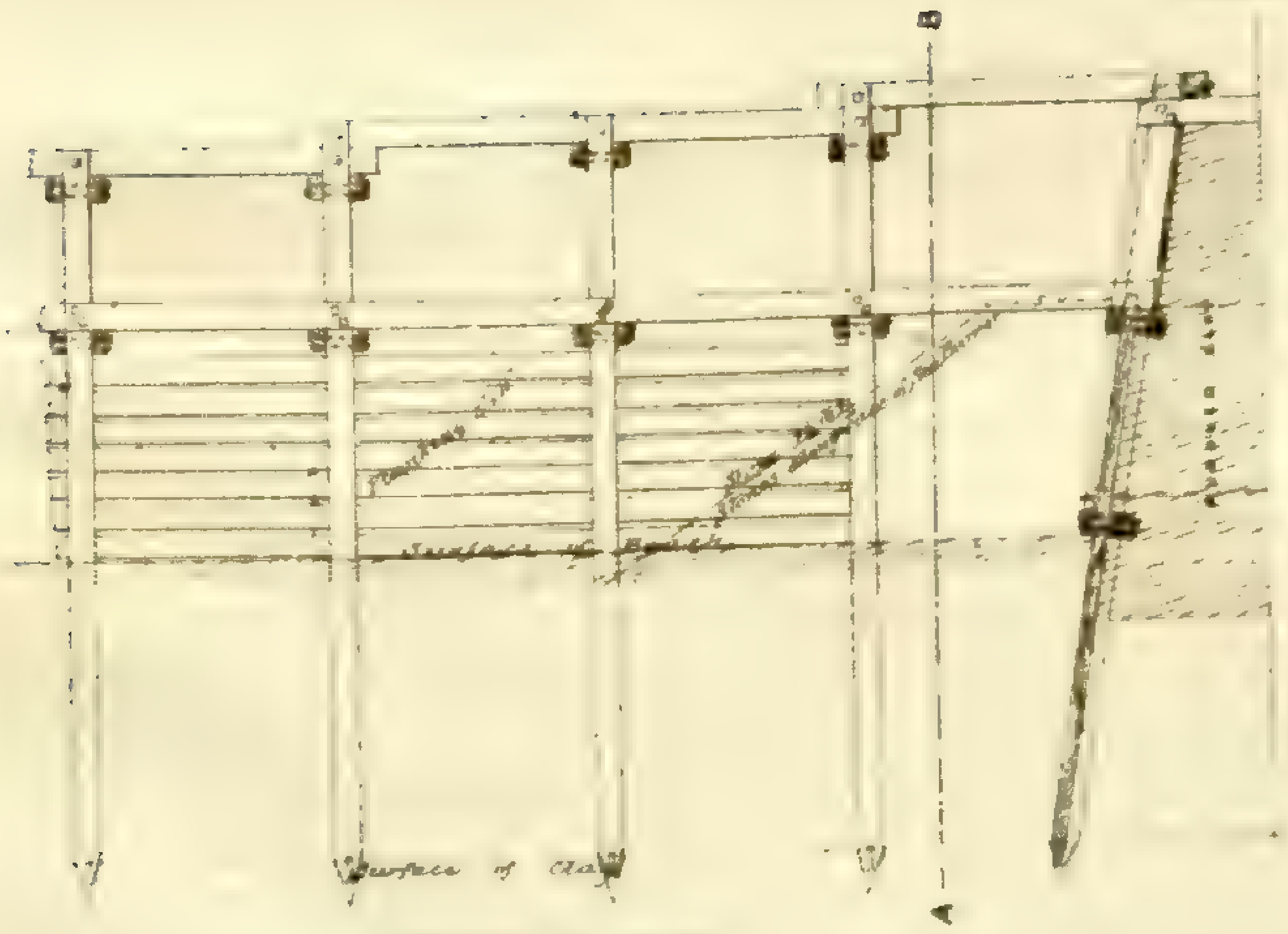
Fig. 2



ELEVATION

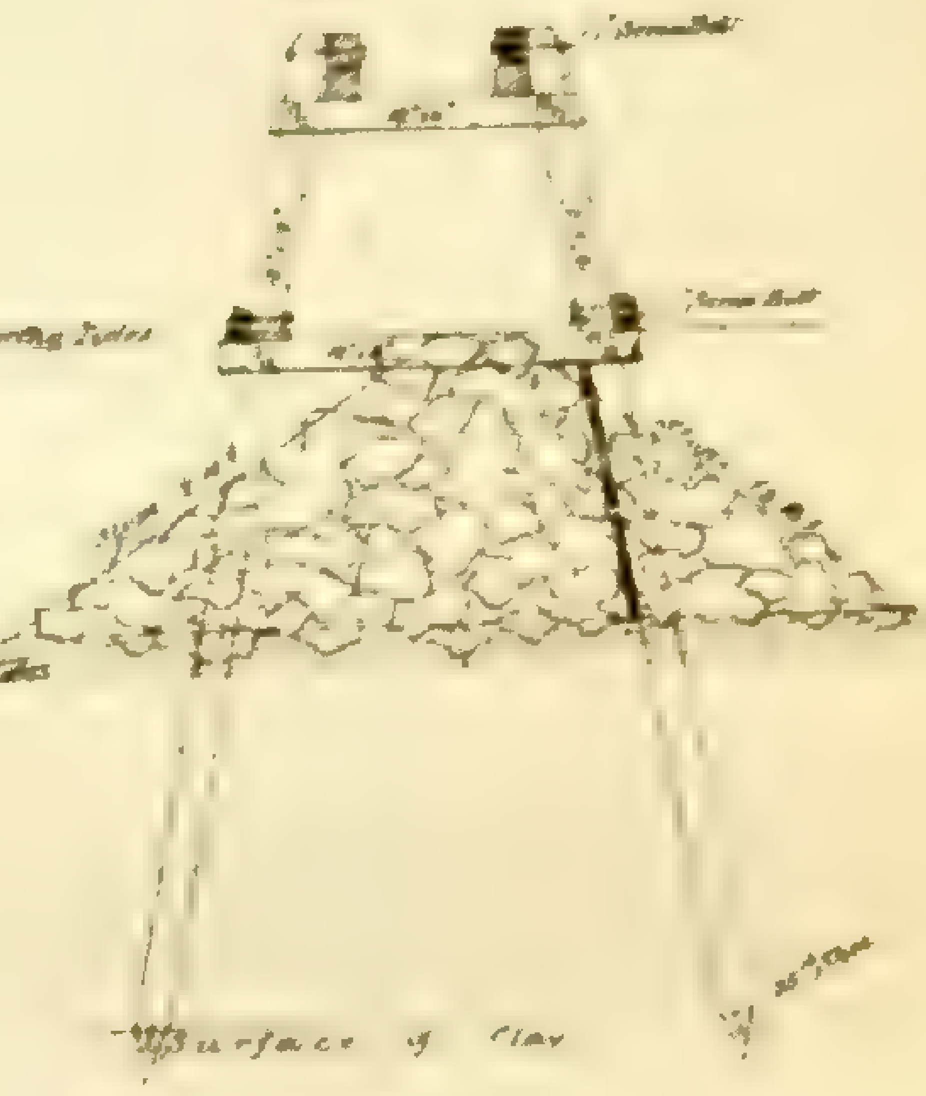
Scale 8 ft. to 1 inch

Fig. 3



ELEVATION OF GROYNE

Fig. 4



SECTION A–B

Showing Stone Filling

Scale 8 Feet to 1 Inch

The snags cast up after every flood will no doubt dangerously affect the groynes when first constructed, as they would then have a large portion above the surface of the beach, but such risks must be unavoidably encountered. Hurriedly constructed works such as have hitherto been in vogue are seldom satisfactory, for permanent results can only be obtained by a system of management pursued when opportunity favours, the best time for constructing the groynes being at the period of extension of beach.

ART. XIII.—*How New Zealand may continue to grow Wheat and other Cereals.* By JAMES C. CRAWFORD.

[*Read before the Wellington Philosophical Society*, *3rd August*, 1878.]

WE have all heard of the exhaustion of soils in new countries from the system of taking crop after crop of the same grain off the land year after year without manure, so that eventually the richest soils have been reduced to a barren state, and have refused any longer to yield returns to the husbandman.

Thus the fertile bottoms of Virginia were impoverished—although, I believe, it was by tobacco and not by grain—and thus the former wheat-growing lands of Campbeltown and Appin, to the southward of Sydney, now refuse to grow wheat, and are only used for the growth of oaten hay, which, the grain not being ripened, takes little out of the soil.

The immense wheat-fields of South Australia, which now give so large an export to that colony, must, in course of time, share the same fate, if continued on the same system, and even now the yield per acre is very small.

Wheat-growing has become an important industry in New Zealand, and the returns from the provincial districts of Canterbury and Otago have for several years past been very large.

New Zealand soils will not long, however, stand the system of cropping above described, for a very few years will exhaust the constituents required for a grain crop. Let us consider, however, how grain-cropping in this colony can be put upon a permanent footing.

We must not be too hard upon the farmers who exhaust their soils, and supply no manure to make up the waste, because, from the system of farming necessary in a new country, it is not easy, perhaps it is impossible, to obtain the required supply of manure. In Great Britain and other thickly-peopled countries, the farmer lays his plans to provide a supply of manure for himself. He has either a dairy, or he stall-feeds oxen, or he

keeps a flock of sheep to feed off his turnips. He has probably, also, a town or large village in his vicinity, from which he can purchase house-manure; and, under the system of high farming, other manures are brought to him from all parts of the world.

It probably would not pay in a new country to go into the elaborate system of farming which is practised in an old one. Much may, however, be done in this direction; and if we contrast the farm work of Otago with that of the rest of the colony, we will see that it can be done to advantage.

It may be that most of the wheat crops now grown in New Zealand are only preparatory to laying the land down in grass. In that case there is little harm done. The land is not exhausted, and after being for some years under grass, may be again broken up and cropped; but what I propose to consider is whether we can hit upon an economical plan of continuing grain-cropping without a rest under grass.

There is nothing new in what I propose to state. It is only a reiteration of well-known facts, but facts which, strange to say, are seldom known to the farmer. He knows that his land is liable to exhaustion, but of the constituents which are taken away in the grain removed, or of how to replace them, he is generally ignorant.

The chief constituents of a grain crop which are carried away with the grain are only three in number—viz., phosphate of lime, potash, and nitrogen. The two former, when once exhausted, cannot be replaced except by carrying them to the ground, or by the slow process of the land lying fallow, or in grass, until fresh supplies which may still remain in the soil shall be released, and put in a condition to furnish food to plants.

With regard to nitrogen, there is an ample supply in the atmosphere, and, if I remember right, Liebig originally held that no nitrogenous manures were necessary, but afterwards, considering the effect of guano and of muck, changed his views on this point, and came to the conclusion that the nitrogen of the atmosphere in, I suppose, the form of ammonia, did not assimilate with sufficient rapidity to obviate the necessity for nitrogenous manures, and that therefore these manures must be provided.

Now, leaving aside for the time the question of the supply of phosphate of lime and of potash, let us consider how the supply of nitrogen may be most readily brought about. No doubt the simplest plan would be to purchase and apply Peruvian guano, but I wish to arrive at the result without an outlay of money. If we go back to the time of the Romans we find that they supplied nitrogen by growing and ploughing in lupins. Now any of the bean tribe will answer for the purpose, these plants being rich in nitrogen, and, when ploughed in, the decomposition which is set up places the nitrogen in a state to be assimilated by plants.

Can we in the climate of New Zealand grow a crop of some plant of the bean tribe, after the grain crop has been harvested, so as to be ready to be ploughed in before the next year's grain crop is sown? If we can do this, then, with a supply of phosphate of lime and of potash when required, we might grow wheat every year. I think this might be done in the North Island, but as regards the wheat-growing districts of the South, it may be doubtful. However, I suppose the plan would be to grow and plough in a bean crop whenever it should be thought necessary, if a crop of turnips, or vetches, fed off by sheep, should not be found equally satisfactory.

The main point, however, is the supply of phosphate of lime. As a rule, the soils of the colony are deficient in this mineral, and every effort of the farmer should go to increase it in quantity. As the best supply of nitrogen would be derived from Peruvian guano, so probably the readiest supply of phosphate of lime would be from the phosphatic guanos. But we have a grand supply of phosphate of lime within the colony without going abroad to look for it. We have over 12,000,000 sheep, and a corresponding number of great cattle. We have a large supply of bones every year, much of which is exported. Not a pound of bones ought to leave new Zealand, but, on the contrary, they should be imported from Australia or elsewhere. We have plenty of sulphur. The manufacture of sulphuric acid should be commenced. Bones treated with sulphuric acid in a state of readiness for use, and other manures, such as nitrate of soda, can be manufactured when sulphuric acid is procurable. A country which contains a liberal supply of sulphur, and in which the inhabitants are intelligent enough to understand the uses of sulphuric acid, is placed at an immense advantage over countries deficient in this mineral. Both in agriculture and in manufacture the uses of sulphuric acid are manifold, and perhaps it is only second to coal in productive economy. How much more is the presence of sulphur a God-send in a country so remote from the rest of the world as is New Zealand, because sulphuric acid is a dangerous commodity to send by sea, and in consequence, when brought from Europe, is very expensive.

It is to be hoped, therefore, that the manufacture of sulphuric acid within the colony may be soon commenced, and then the farmers may be supplied with a liberal quantity of superphosphates.

An excellent example of the use of supplying phosphate of lime may be seen in the treatment of the clay soils near Auckland. These soils appear to be in their natural state entirely devoid of this mineral, and are in consequence extremely sterile. A liberal dose of crushed bones makes them productive, and without this supply their cultivation is useless, as they will give no returns.

It might have been of advantage to the farmers of the hills near Wellington and other parts of New Zealand, if the phosphates there had also been entirely wanting, because by this time they would have learnt the necessity of applying them. As the case stands the phosphates are merely deficient in quantity, not absent altogether, and thus the farmers have been able to get along somehow. A liberal dose of bone-dust, repeated when required, would vastly increase the produce of their soils.

I am inclined to suppose that there is generally a sufficient supply of potash in the soils of this Colony, but no doubt the quantity is constantly subjected to diminution. On grazing lands a considerable portion is annually removed in the wool, and sent to England, and in cultivated land it is carried away as a constituent of the crop, and if not restored in manure is lost to the soil.

I suppose fresh supplies of potash might be procured by taking more care of our waste timber—by saving ashes from timber land when cleared, and from the toppings of branches at the saw mills, and also from seaweeds.

Growing continuous grain crops is not confined to new countries but has been tried in England—of course in that country with the use of manure.

I think that Mr. Dawes, the celebrated agriculturist, first tried the system, and I have come across an account of some experiments in the same direction, conducted at Paxton in Berwickshire. These experiments seem to have extended over seven years, and a statement of the results may prove of interest. I therefore give it:—

Four-Acre Field.

Year.	Kind of Crop.	Kind of Manure and quantity per Acre.	Value of Crop per acre with Straw. £ s. d.
1870 ..	Turnips, after Barley ..	Portion of turnips eaten on ground by sheep	9 17 6
1871 ..	Hay	2 cwt. nitrate of soda	11 13 4
1872 ..	Oats	1½ cwt. guano	9 0 0
1873 ..	Beans	2 cwt. dissolved bones	14 10 0
1874 ..	Wheat	20 tons farmyard dung	10 0 0
1875 ..	Barley	1½ cwt. nitrate of soda, and 1 cwt. superphosphate of lime	9 10 0
1876 ..	Barley	1½ cwt. nitrate of soda, and 1 cwt. superphosphate of lime	9 10 0
1877 ..	Barley	2½ cwt. nitrate of soda, and 2 cwt. superphosphate of lime	7 5 8

Seven-Acre Field.

Year.	Kind of Crop.	Kind of Manure and Quantity per Acre.	Value of Crop per acre with Straw.
			£ s. d.
1870 ..	Turnips ..	14 tons farmyard dung, and 3 cwt. guano	6 0 0
1871 ..	Barley	Turnips eaten on ground by sheep ..	8 11 8
1872 ..	Hay	2 cwt. nitrate of soda	9 6 8
1873 ..	Oats	No manure..	7 15 0
1874 ..	Beans	2 cwt. bones	12 0 0
1875 ..	Barley	1½ cwt. nitrate of soda, and 1½ cwt. superphosphate of lime	10 3 4
1876 ..	Barley	1½ cwt. nitrate of soda, and 1 cwt. superphosphate of lime	8 17 1
1877 ..	Barley	2½ cwt. nitrate of soda, and 2 cwt. superphosphate of lime	7 0 0

I should be inclined to think that continuous corn-growing in Great Britain could hardly come into competition with a rotation of crops, for one reason in particular,—viz., the want of provision for destruction of weeds. This is a difficulty which would also occur in New Zealand, where, from the moisture of the climate, weeds are very difficult to be kept under. If a good payable system of rotation for this colony could be hit upon, I am inclined to think it would beat the continuous corn-growing system. If, however, farmers will continue to work their land on the latter plan, I will again reiterate that they cannot continue to do so for many years without giving and keeping up a supply of phosphate of lime, of potash, and of nitrogen.

I have seen it stated, on excellent authority, that pastures which are deficient in phosphate of lime in the soil ought never to be used for breeding sheep; for the lambs on such pastures scour, get pot-bellied, are deficient in size, and many of them die. This seems according to reason, for if there is an insufficient supply of mineral to form the bones, the animal must probably also suffer in other ways. Possibly, when the sheep has attained full growth, and his bones are fully formed, these pastures may do for fattening him; or, if it will pay, the land may be treated with bone-dust, but it would be absurd to suppose that this could be done with profit on a large sheep-run and with stock at present prices.

Art. XIV.—*On the Rock Paintings in the Weka Pass.* By A. Mackenzie Cameron. Communicated by Prof. J. von Haast, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, 4th April,* 1878.]

"1, Cascade Terrace, Cascade Street, Paddington,
"Sydney, 9th February, 1878.

"To Professor Julius von Haast, President Philosophical Institute, Christchurch, Canterbury, New Zealand.

"My Dear Sir,—You have already received my hurried acknowledgment of the receipt of your kind communication enclosing photographs of the newly-discovered rock paintings in New Zealand, with notes on them supplied by yourself and the Rev. Mr. Stack.* I now proceed to offer some suggestions on the figures, premising that being connected with the Society of Biblical Archæology of London, and having in the course of extensive travels in old Asiatic countries come across and studied many very ancient remains (some fully 3000 years old), and further, having made early alphabets and symbols special studies, I was entrusted lately in London for elucidation, by my very old friend, Dr. Thomas Allan Wise, M.D., F.R.S. Edin., with drawings of rock sculptures and figures which he (delighting in antiquarian researches) had at considerable labour and expense made in various parts of the kingdom of Scotland, and which may be seen on Plates in the 'Transactions of the Royal Society,' Vol. XXI. I have thus materials at hand for comparison besides my own studies and experience. I may add that I am pleased to see Mr. Stack's name, as I happened in England to be well-known to, and sometimes associated in work with, his venerable and respected father, the Rev. James Stack.

"To proceed to the figures, I have to state—(1.) That such ancient remains are to be found in such distant parts of the globe as Ireland, Scotland, India, and Borneo, and the distance from the last to New Zealand is not so great as the distance of Ireland or Scotland from India. (2.) In the western countries there are two sets of figures—one Eastern in origin and pre-Christian, and the other Native, and post-Christian. They are easily distinguishable. (3.) The pre-Christian figures were made by Phœnician traders and Buddhist missionaries from India. Both were of the same age of the world's history. The first were well known for maritime enterprise, and if they made for one extremity of the world in Cornwall for tin, and down south-east to Taprobane and the *Aurea Chersonesus* for other merchandise and gold, why should it be improbable that they visited the 'Isles of the Sea' expressly mentioned by Ezekiel, and reach to the end of the chain which begins with Sumatra and ends with New Zealand? We have

* Vol. X., p. 44, *et seq.*, pl. I.

clear philological testimony that the *serpent-race* of India in early times obtained a foothold in New Zealand. This will be further brought out below. Again, as to the Buddhist missionaries, they were noted for their enterprise and travels for their faith. They carried their faith, doctrines, and symbols to the extreme east, north, and south of the great continent of Asia; over seas, deserts, and extended barriers of eternal snow, and all through to the extreme west of Europe. Is it improbable that, whether with the *serpent-race* from India, or in Phœnician vessels, they arrived in New Zealand? The association of the Buddhist cross with Phœnician letters on inscriptions in the west is a fact.

"These observations will serve to clear up the following remarks on the figures transmitted by you:—First, I may say that the figures strike me as divisible into pre-Christian, Indian, symbolic, and later native. The pre-Christian are generally the hieroglyphics, while most of the drawings of men with marine monsters appear to be later native. This may be a mere supposition, but you have other circumstances to decide this point. Secondly, figures 2, 6, 13, 21, 21A, and, perhaps, 24, constitute, along with, very probably, 15, 16, 18, one group—the Trinity symbol—and are pre-Christian. I can only briefly explain here this symbol. It may suffice to state that spirit, matter, and organised life, as the result of the action of the first on the second, are supposed to form the *pan-theo-cosmical* (if I may coin such a word) nature or universe of the ancient religious creed of India, and which was carried by the Buddhist missionaries over the world. The symbol of this cardinal and esoteric doctrine of religion was three circles near each other, and, in my opinion, also two joined circles, crossed with the zig-zag figure (supposed by some to be also a Masonic symbol) usually called the 'spectacle ornament,' the crossing zig-zag figure representing probably spirit. We find these symbols alike on great Buddhist temples in India, on the Bhilsa 'topes,' on the standing stone in Aberdeen, and on the Dingwall stone in North Britain. The figures composing the symbol are either plain or ornamented, and disposed in various ways. The variations are remarkable, and give a clue, as I believe, to the true signification of figures 2, 6, 13, 15, 16, 18, 21, and 21A. In all these, the three parts are distinctly made out, especially in figures of 2, 6, 21, 21A. In my opinion, figures 13, 15, 16, 18 are similar to the 'spectacle ornament' of North Britain. Figure 14 may be a representation of the same symbol, or of a Buddhist temple, the form of which figures in North Britain, explaining unmistakably the zig-zag line, and the sacred nature of the Trinity symbol.

"I make no observations on fig. 17, of which there are several similar representations in other parts of the world. Figs. 4, 9, 22, and perhaps 24, also have counterparts elsewhere. The Buddhist cross (and Phœnician

tau) is probably intended in figs. 5 and 12, though the execution is very degenerate. (The same may be said of all the other symbols). The very remarkable figure 23 probably represents the early Phœnician and Hindoo Fish-god. I have certainly seen it before somewhere in India. This establishes the early age of the drawings, the race of workmen, and the sacred character of the drawings. (See also the philological notes lower down.) You will perceive that I have not noticed the theory of figs. 2, 6, 13, 21, 21A, representing any oriental characters, ancient or modern, for this reason: that amid the numerous and complicated alphabetical forms of various Eastern languages some resemblance is sure to be found. In this view I might recognise fig. 2 as Arabic, figs. 13 and 21 as Sanscrit, and fig. 24 actually as the Hebrew *aleph*. Fig. 2, to me, is conclusively a Buddhist symbol. Fortunately, however, your communication encloses several notes furnished by Mr. Stack, and I find there abundant philological proof that New Zealand had early intercourse with India.

"*Te kahui tipua*—the definite particle (Greek *to*, English *the*, Malay *itu*, etc., etc.), limiting, indicating; *kahui tipua*, the deceitful, wicked dog-race (Malay *tipu*, deceitful, and *kuh*, the dog-race), remnants of whom are still to be found in the north-west of Burmah. Of course I may be mistaken in this interpretation, and I should wish to know which is the adjective.

"Again: *Ngapuhi*—*nga puhi*, the *serpent-race*. This race is to be found in parts of India, and plays an important part in early Indian history. My Hindoo mythology is rather dull at present, but, if remembrance serves me, I believe the Aryan race had a long and desperate contest with the earlier *serpent-race*, and, succeeding, drove these last into hills and mountains, and beyond the seas. Sanscrit *naga*, great serpent; and *puh*, race, descendants.

"I may be tempted on to great length with these and other words furnished in Mr. Stack's letters, and therefore shall conclude here, only adding that should any portion of the observations I have made require further explanations I shall be happy to give them to you.—I remain, &c.,

"A. Mackenzie Cameron."

"P.S.—With reference to some of your own remarks, made in your last annual speech, I should state that figure 15 resembles an Indian bow and arrow; figure 18, a war conch; and figure 14, a broad-brimmed hat, nearly similar in shape to those used in Malayan countries. Notwithstanding all these resemblances, I still adhere to the opinion that they represent Buddhist symbols. The P.S. of your own speech would appear to dash my theory to the ground, but what is the meaning of your own words, 'they are of a more primitive nature'? and of Mr. Stack's assigning them to 'the oldest inhabitants of this island—*somewhat mythical people*—of whom there are any

traditions.' If furnished with the necessary philological and ethnological materials I might be able to indicate the early history of your island."

Postscript by Professor von Haast.

It is scarcely necessary to point out the important nature of this communication, which opens up quite a new field for research into the early history of these islands, and goes far to prove the great antiquity of the paintings in question. In reference to Mr. Cameron's views, I may, however, be allowed to observe that these red paintings have evidently all been executed at the same time, and cannot therefore represent two distinct periods, or have been the work of two distinct races. In stating in the postscript to my address that when speaking of the great antiquity of these paintings, I did not do so in the European sense, but only as far as there were existing reliable traditions of the present Native inhabitants of these islands, I did not wish to give any expression as to my views of what the real age of these paintings might be. Before doing so I wished to obtain more material. However, anybody acquainted with my own views in regard to the great number of years these islands have been inhabited, and the long period of time since the Moa has become extinct through the agency of man, of which we have ample geological evidence (the only one to be trusted), will easily understand that I can only coincide with Mr. Cameron's opinion as to the great antiquity of the paintings in question, even in the European sense.

Art. XV.—*Barat or Barata Fossil Words.* By J. Turnbull Thomson, F.R.G.S., F.R.S.S.A., etc.

Plate IV.

[*Read before the Wellington Philosophical Society, February,* 1879.]

This continues the subject of three preceding papers*, and the heading requires some explanation. Barat is the Malay traditional and poetical name for Hindustan, and to this day they speak of the *angin Barat*—that is, westerly, or wind of Barat; as they do of the *angin Jawa*—that is, the southerly, or wind of Java. Barata, or Bharata, is the ancient term for their country by the natives of Hindustan. In the language of Madagascar, allowing for difference of phonology, precisely the same word is used for the North, viz., *avaratra*, whose winds wafted commerce from the parent country, viz., South India. We use the term parent on the force of the facts elicited in our preceding investigations.

* Whence of the Maori, Trans. N. Z. Inst., Vol. IV.; Barata Numerals, Vol. V.; Philological Considerations on the Whence of the Maori, Vol. VI.

The term "fossil words" signifies words embedded in a language, or which have not been eradicated by foreign influences—such as the Saxon words in the modern English language. The roots of the language will be found to consist of these; hence they remain as witnesses of derivative, national or tribal connection with the parent region, however remote in time or distant in space. Fossil words, then, furnish as certain a clue to connection of races as either idiomatic or phonetic similarity,* though this opinion is disputed. Root or fossil words, it has been shown in previous papers, are only to be eradicated with the extinction of the race, and to this branch we at present address ourselves.

The previous papers on this subject, whose first object was to investigate the whence of the Maori, *i.e.*, the tribe that inhabits New Zealand, confined their scope to the Malayan, Malagasi, and Polynesian dialects. In the present paper I have prosecuted my enquiries far beyond into the regions of Asia, Africa, and Australia, in which labour I was assisted by the works noted below.†

The basis of my investigations have been the Malayan Language, with which my long sojourn in the Far East made me familiar, but the present work has led me into a scrutiny of over four hundred languages and dialects.

The conclusion that I was brought to previously, viz., that, counter to popular opinion, the Maori and hence Polynesian race, was not originally from the Malay (though it might be through or with them), but from a race or races which in pre-historic times inhabited Hindustan, seemed to claim further demonstration than my materials could at that time afford. In my recent visit to England, therefore, I collected all the works bearing on the subject that I could obtain.

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* For instance, Malay has a compounding construction, Malagasi an inflecting, though both are admitted to be originally one.

† Non-Aryan Languages of India and High Asia, by W. W. Hunter; Languages of India, by G. Campbell; Polyglotta Africana, by S. W. Koelle; Australian Languages, by William Ridley; Mosambique Languages, by W. H. J. Bleek; Malagasi, by Julius Kessler; Kafir Language, by John Ayliff; Swahili Handbook, Shambala Language, Yao Language, all by Edward Steere; Malagasi Grammar, by David Griffiths; Enguduk Iloigob Vocabulary, by J. Erhardt; Dictionary of Tshi, Akra, &c., by Christaller, Locher and Zimmermann; Vocabulary, Haussa Language, by J. F. Schon; Languages of Sierra Leone (anonymous); Bullom Grammar, by G. R. Nylander; Western and Central African Vocabulary (anonymous); Dialects in Africa, by John Clark; Bornu and Kanuri Languages, by Edwin Norris; Dialects of Nicobar and Andaman Islands, by F. A. de Röepstorff; Fijian Dictionary, by D. Hazlewood; Samoan Grammar and Dictionary, by George Pratt; New Zealand Language, by William Williams; Hawaiian Dictionary, by Lorrin Andrews; Japanese Dictionary, by J. C. Hepburn; Comparative Vocabulary, Malay Archipelago, by Wallace, &c., &c.

The present paper is thus principally devoted to the following question, viz., by analogy in fossil words or radicals, how far are we justified in denoting Hindustan as the original seat of the Malagas-malayo-polynesian race, which, for the sake of brevity and distinction, I have taken the liberty to term Barata. In attempting to solve this question, we must have regard to other theories that have been propounded by various authors. The most generally accepted theory, viz., that the Malagaso-polynesians were of Malay origin, I have already dealt with in my previous essays. Another theory I have since observed to be that the Malayo-malagasi had sprung from the Polynesian, the supporters averring that as the Polynesian was the more primitive and ancient section, he must have been the progenitor. To this the following considerations suggest themselves: 1st. Admitted that the Polynesian is the most primitive and ancient section, this only denotes that he was the first to migrate from his original seat, when that seat—whether in Africa, Asia, America, or Australia—was in possession of a primitive and ancient ancestry; and as there have been waves of migration from time to time, the most primitive have stretched out furthest.* 2nd. The over-running of skilled populous and armed nations by the simple weak and defenceless, is contrary to all experience, ancient or modern. 3rd. Another theory has been suggested, that Africa was the original seat of the race, another that it was in Egypt; but as these have had little acceptation, I merely notice the same.

Before entering into the comparison of words in different dialects or languages, in order to judge of the connection of race we must hold in view this fact, that the radicals bear but a small proportion to the whole, thus in an English dictionary of 90,000 words, not more than 4000 or $\frac{1}{22}$ part are Saxon. Hence, amongst the races whose languages we are about to consider, and whose dictionaries do not count over 5000 to 6000 words, we must be prepared to find not over 300 words more or less which can come under the denomination of radical terms or fossil words. This fact at the same time facilitates the investigation, making it less laborious.

The number of works that can be compared are further curtailed by the subject or object being only known in portions of the regions inhabited. Thus while I have gone over many full vocabularies, I have been forced to strike out many of the words from the above cause. For instance, the cocoa-nut well known to the Malay is not known to the Maori. In a similar manner the deer, elephant, plantain, rice, &c., are well known in some regions but not in others—hence, though they come under the designation of radical terms, they are inapplicable in our enquiry.

* See Trans. N.Z. Inst., Vol. IV., 1871, p. 47.

We must again guard against the error of accepting all radical terms as proving affinity of race; the terms most certain are those which are connected with immediate surroundings or events, such as for parts of the body, head, mouth, feet, &c., the principal physical objects—sun, moon, stars, earth, &c.; articles of food—water, rice, fruit, &c.; calls to companions as come, go, give, &c. If the terms be not connected with immediate surroundings then they become less valuable in support of proof of racial affinity, as for example:—

—	In Malay Archipelago.	—
Dog ..	*asu, gaso, kaso, aso*	*tasu* Angami Naga, *azz* Nowgong Naga, East of Bengal.
Horse ..	*kuda*	*ghoda*, Kiranti, Nepal; *ghora*, Nepal; *kodo*, *kudata*, Central India; *kudre*, Southern India.
Crow ..	*gaga*	*gagah'-po*, Kiranti, Nepal; *gugga*, Central India; *kakka*, Southern India.
Buffalo ..	*kurbau*	*krebo*, Teressa, Nicobar Islands; *kla-ou booh*, Talain, Pegu.
Cocoa-nut	*nior*	*nio*, Malagasi; *nazi*, Swahili; *nyu*, *nui*, *niwi*, *nua*, *niula*, *luen*, *nuim*, etc., Malay Archipelago; *niu*, Samoa and Hawaii.

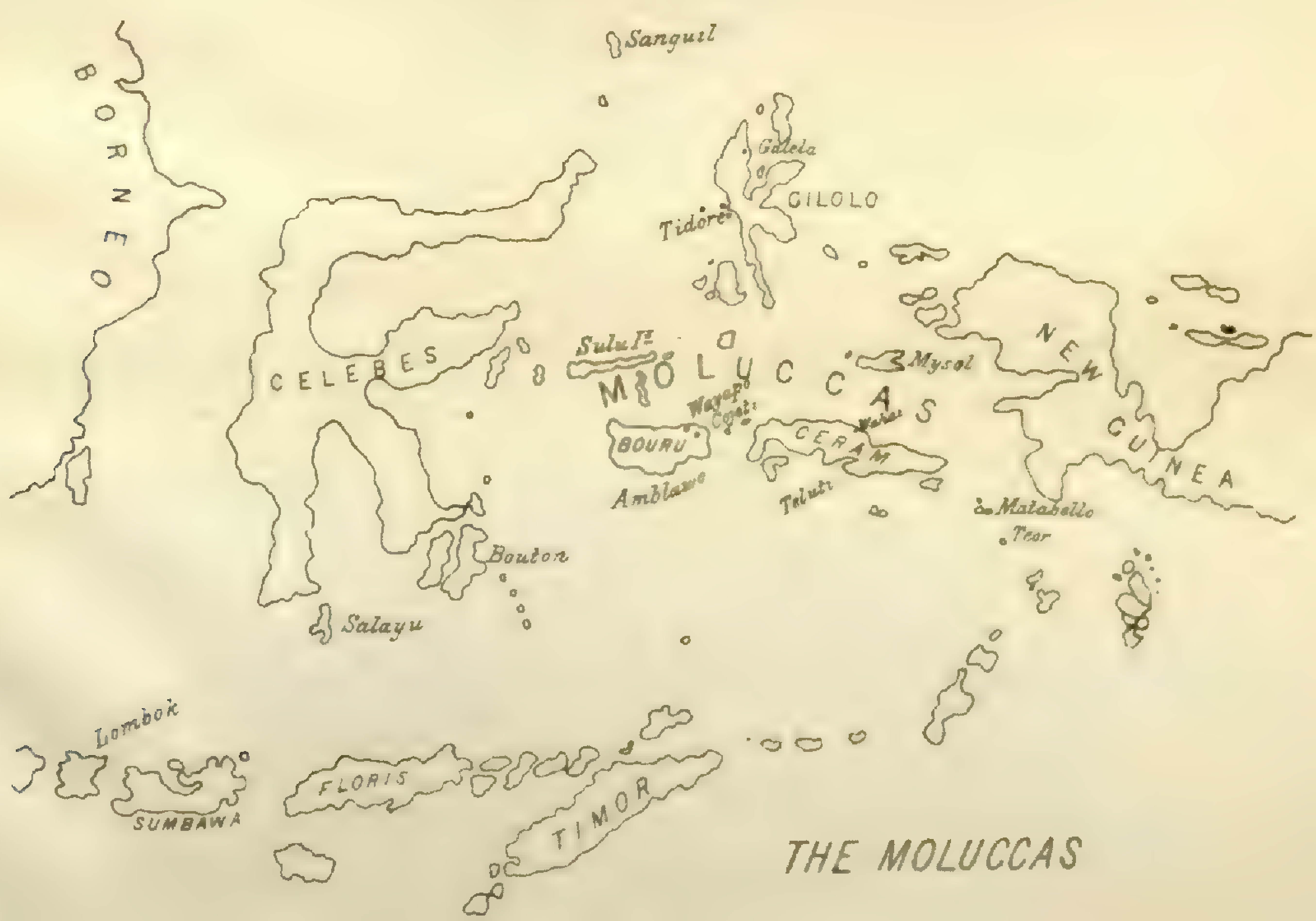
Here the words dog, horse, crow and buffalo being similar, or nearly so, in Malay and several races of Asia, do not indicate affinity, but only that such animals had been derived from thence. On the contrary the radical Malay word *nior*, having wide similarity from Africa to Polynesia, may be taken to indicate affinity of race, for as the cocoa-nut grows on the sea-shore, letting its fruit fall to float and be carried to all tropical regions, it may be supposed to have preceded the emigrant tribes; thus, as they approached each island or shore, they carried the fossil word and applied it to the same species of tree, in whichever parts of their vast regions it had drifted and germinated, or they may have carried, exceptionally, the fruit with them. Again, in the following examples:—

—	In Malagasi.	—
Dog ..	*amboa*	*imbua*, Inhambane; *imbua*, Sofala; *umboa*, Cap Delgado.
Cattle ..	*ombi*	*ngombe*, Tette, Sena, Quellimane, Mosambique, Cap Delgado, etc.

The dog and the crow are not indigenous words of Malagasi, but derivative from Africa, the designations having been imported with the animals themselves.

Hence, in choosing words found in the various dictionaries for comparison, I have had the above considerations in view, and have adopted only such as can be held as radical, indigenous, or truly *fossil*. By this means the racial affinities of the separate and far distant tribes can be indicated in the Barata of the tropics as in the Gypsies of Europe or the Portuguese in

Sketch Map of
INDIA
Shewing the Distribution of
LANGUAGES.
by J. Beames, M.R.A.S.
Reference.
Indo-Germanic Languages
1 Indic Class. (Hindi, Bengali, Panjabi, etc.)
2 Iranic Class. (Pushtu.)
Turanian Languages.
1 Thaic or Siamese Class. (Mon of Pegu.)
2 Himalayic Class. (Bhotia, etc.)
3 Lohitic or Burmese Class
4 Kol Class.
5 Dravidic Class. (Telugu, etc.)
BAY OF BENGAL
PUSHTU
TIBETAN
HIMALAYIC
BURMESE
PANJABI
HINDI
Rajput Dialects
SINDHI
BRAHUI
GUJARATI
MARATHI
KOL
BENGALI
ASSAMESE
DRAVIDIC
TELUGU
KARNATAKA
TAMIL
TULUVU
MALAYALAM
SINGHALESE
Bombay
Calcutta
Madras
Delhi
Lahore
Goa
C. Comorin


BORNEO
CELEBES
MOLUCCAS
NEW GUINEA
GILOLO
Sanguil
Galela
Tidore
Sula Is.
Mysol
BOURU
CERAM
Amblawe
Teluti
Matabello
Teor
Bouton
Salayu
Lombok
SUMBAWA
FLORIS
TIMOR
THE MOLUCCAS

Africa and Asia, though many tribes of both have in these historic times lost their idioms and phonology, but not the roots of their languages.

We may now come to the comparison of words collected from the various sources already stated,* and in commenting on the same it is hardly necessary for me to remark that I do so under the conviction that the insular races were derived from the continental, but I am open to enquiry from what continent or portion of continent:—

1. Arrow: *zana* Malagasi, *panah* Malay, *pere* Maori.

    The glossarial indication would denote in the case of the Malagasi and Malay immediate derivation from Telugu in South India, with affinity to Shan in Indo-China. In the case of the Maori from Garo, N.E. Bengal, with affinity to Great Nicobar, Bay of Bengal.

    The African affinities in each case are doubtful.

2. Bird: *vorona* Malagasi, *burong* Malay, *manu* Maori.

    Malagasi and Malay derived from tribes in Nepal and East of Bengal, Maori from tribes in Indo-China.

    No African affinities.

3. Blood: *ra* Malagasi, *dara* Malay, *toto* Maori.

    Malagasi and Malay derived from Tibeto-China, Nepal, and Bay of Bengal.

    African affinity distant.

4. Bone: *taolana* Malagasi, *tolan* Malay, *iwi* Maori.

    Malagasi and Malay derived from Bay of Bengal, but doubtful; Maori from Nepal, Indo-China and China.

    No African affinities.

5. Dog: *amboa* Malagasi, *anjing* Malay, *kuri* Maori.

    Malagasi from Bay of Bengal, doubtful; Malay from Nepal, Maori from Nepal and Indo-China.

    Malagasi from Africa, Maori also from Africa.

6. Ear: *talinhe* Malagasi, *talinga* Malay, *taringa* Maori. All from East Bengal.

    Indications of African affinities.

7. Earth: *tany* Malagasi, *tana* Malay, *one-one* Maori.

    Malagasi and Malay direct from Khond, Central India, less distinctly from Indo-China and Bay of Bengal, Maori from Central India, doubtful.

    No African affinities.

8. Egg: *atody* Malagasi, *telor* Malay, *hua* Maori.

    Malagasi, from Singpho, E. of Bengal, doubtful; Maori from Burma and Indo-China, doubtful.

    Malay from ossa, W. Africa, doubtful.

* See Appendix I.

9. Eye : *maso* Malagasi, *mata* Malay, *kanohi* Maori.
Malagasi and Malay from N. Central and E. Hindustan, Maori from Tibeto-China, Central and Southern India.
Malagasi and Malay have E.W. and S. African affinities.

10. Fire : *afo* Malagasi, *api* Malay, *ahi* Maori.
All from India and Indo-China, indications also from China and Japan, also all allied to Fulah, Africa, but doubtful.

11. Fish : *loaka* Malagasi, *ikan* Malay, *ika* Maori.
All from Nepal, E. of Bengal, Indo-China and Bay of Bengal.
All have indications of African connection.

12. Flower : *vony* Malagasi, *bunga* Malay, *pua* Maori.
All from Nepal, Central and Southern India.
In Africa indications doubtful.

13. Foot : *tongon* Malagasi, *kaki* Malay, *wae-wae* Maori.
Malay from Indo-China and E. Bengal.
Maori has African connection.

14. Hair : *volo* Malagasi, *bulu*, *rambut* Malay, *huru* Maori.
All Tibeto-China and E. Bengal.
African indications doubtful.

15. Hand : *tanana* Malagasi, *tangan* Malay, *kutanga*, *ringaringa* Maori.
All from Hindustan.
All have African indications.

16. Head : *loha* Malagasi, *ulu*, *kapala* Malay, *upoko* Maori.
All from Indo-China, Nepal, Central and East India.
African indications.

17. Hog : *kisoa*, *lambo* Malagasi, *babi* Malay, *poaka* Maori.
All from North, South, and Central India.
All have African affinities.

18. Leaf : *ravina* Malagasi, *daun* Malay, *rau* Maori.
Malay and Maori from Nepal and Indo-China.
Maori has African indications.

19. Light : *maivana* Malagasi, *trang* Malay, *ao* Maori.
Malay and Maori from Bengal and Indo-China.
Malay from Swahili, Africa, doubtful.

20. Moon : *volana*, Malagasi, *bulan* Malay, *marama* Maori.
Malagasi and Malay from Nepal and Indo-China.
Indications in Ibu, Central Africa.

21. Mouth : *vava* Malagasi, *mulut* Malay, *mangai*, *waha* Maori.
All from Nepal, Central and Southern India.
All have African affinities.

22. Night : *alina* Malagasi, *malam* Malay, *po*, *kengo* Maori.
Malagasi and Malay from China and Central India.
No African affinities.

23. Rain : *ranonorana* Malagasi, *ujan* Malay, *ua* Maori.
Malay and Maori have African connection.

24. Road ; *lalambe* Malagasi, *jalan* Malay, *ara* Maori.
All from different parts of Hindustan and Indo-China.
Maori term has indications in Yao, East Central Africa.

25. Sky : *lanitra* Malagasi, *langit* Malay, *rangi* Maori.
All from Nepal and Central India.
No African affinities.

26. Star : *kintana* Malagasi, *bintang* Malay, *whetu* Maori.
Malagasi and Malay, N.E. Bengal, Central and South India.
No African affinities.

27. Sun : *maso-andro* Malagasi, *mata*, *hari* Malay, *ra*, *komaru* Maori.
Malay and Maori from Indo-Tibeto China and Nepal.
Maori has affinity with Haussa, Central Africa.

28. Tongue : *lila* Malagasi, *lida* Malay, *arero* Maori.
Malagasi and Malay from East Bengal and Bay of Bengal.
Malagasi and Malay have African affinities in East Central and South.

29. Tooth : *nifi*, *nifo* Malagasi, *gigi* Malay, *niho*, *rei* Maori.
Malay from Nepal, East and Central India.
Malagasi and Maori have African connections.

30. Tree : *hazo* Malagasi, *pun*, *poko*, *kaiu* Malay, *rakau* Maori.
All from Hindustan and borders.
No African connection.

31. Water : *rano* Malagasi, *ayer* Malay, *wai* Maori.
All from Hindustan and borders.
Malay and Maori have African connection.

32. Yam : *ovi* Malagasi, *ubi* Malay, *uwhi-kaho* Maori.
No Asiatic or African connection.

33. Hot : *mafana* Malagasi, *panas hangat* Malay, *wera* Maori.
Maori from Tamil, South India.
No African connection.

34. Raw : *manta* Malagasi, *manta* Malay, *mata* Maori.
All from East of Bengal and Bay of Bengal.
No African connection.

35. Red : *mena* Malagasi, *mera* Malay, *whero* Maori.
All from South and Central India.
No African connection.

36. Ripe : *masaka* Malagasi, *masa* Malay, *maoa* Maori.
All from Nepal.
No African connection.

37. Small : *keli* Malagasi, *kichi* Malay, *riki, iti, nohi-nohi* Maori.
All from Hindustan and borders.
No African connection.

38. Come : *avi* Malagasi, *mari* Malay, *mai* Maori.
All from Hindustan and borders; also, Chinese connection.
No African connection.

39. Five : *dimï, limi* Malagasi, *lima* Malay, *rima* Maori.
No Asiatic or African connnection.

40. Six : *enina, oné* Malagasi, *anam* Malay, *ono* Maori.
No Asiatic or African connection.

41. Seven : *fito* Malagasi, *tuju* Malay, *whitu* Maori.
Malagasi and Maori from Central and South India, Malay from East Nepal.
No African connection.

42. Eight : *valo, varlo* Malagasi, *delapan* Malay, *waru* Maori.
Malagasi and Maori from Central India.
No African affinities.

43. Nine : *sivi, siva* Malagasi, *sambilang* Malay, *iwa, iva* Maori.
Malagasi and Maori from Indo-China.
No African affinities.

On analysing the comparative vocabulary given in the appendix, I find that the analogies are much greater as between the Barata terms and Asia than as between these and Africa; and of the list of 43 given, 235 analogies, or close analogies, are found in the primitive languages of the former, particularly in Hindustan, while 97 analogies are found in Africa—principally in the Mosambique districts—but in most cases the analogies are by no means so perfect.

It may be further remarked, that of the 43 Barata terms given in our list, all except two are found embedded in the languages of South Asia, while 17 of them are not found in any African language.

Proceeding on our basis then—viz., that the Malagas-malayo-polynesian tribes derived their origin from the continent—not the continental tribes theirs from the islands—which theory some ethnologists support; it can scarcely now be doubted (that is, if the testimony of language have any value), that the origin of the Barata race extending over the tropics from Madagascar to Easter Island was in Hindustan, where the roots of their language are yet found so profusely preserved.

Further, that many of these words should also be preserved in Africa is not to be wondered at, seeing that the negro race had in archaic times such large expansion* over all the regions under review, and between whose tribes and nations there has been immemorial intercourse.

The question still remains—from what part of Hindustan did these great Island Tribes emanate? The reply will be best made by reference to the accompanying map (pl. IV). It will be seen from this that Hindustan is now overrun by two distinct sections of the human race—viz., Indo-Germanic or Aryan and Turanian; or, in other words, the one Caucasian, the other Mongolian; the one occupying the western and northern regions, the other the southern and eastern; and in overrunning Hindustan have they extirpated the primitive races? not entirely; many of these remain, much modified, it is true, in colour and physiognomy, but little in language.† The roots of a language die only with the tribe's extirpation. Hence, it is not in the languages of the intruding sections that we have found the Barata fossil words; but, for the most part, in the various small tribes, yet preserved in the obscure portions of their territory, difficult of access, such as under the Himalaya, Jynteah and Nilgherry mountains. In these, the undeleted glossarial remains of what had once been the language of a numerous people, we have witnesses to facts and conditions of nations long since past and preceding historic record.

Small tribes may have found their way towards the Tropics by divers routes, and particularly by those through the Malay Peninsula, Tenasserim coast and islands, but the section or nation that spread its influence, girdling two-thirds of this globe, could not have been one or more of these.

It is to South India, therefore, that we must look. For the inhabitants of this region have from times immemorial carried on trading expeditions, westerly to Africa and easterly to the Moluccas, a circumstance that can neither be stated of the natives of the rest of Hindustan nor of any of the Malayan states. The original seat of the great Barata race can then be only fairly sought for or denoted in South India, which commands the routes east to Malayo-Polynesia, west to Madagascar, and whose population, eminently maritime, were competent to the task of navigation. Thus we are led to the same conclusion as stated in my previous essays.‡

In my researches I have had to scrutinise the Sanscrit terms, several of the Asiatic and African-Arabic dialects, Bask, Finnic, Magyar, Turkish, Circassian, Georgian, Mongolian, Muntshu and Japanese languages, without finding analogies. I have also examined twenty languages of Australia, and, amongst these, instances of but very exceptional and remote affinities

* See Trans. N.Z. Inst., 1871, p. 32. † See Trans. N.Z. Inst., 1871, p. 36.

‡ Trans. N.Z. Inst., 1871, p. 48.

are detected, and none such as would indicate connection. The Barata language must therefore be held to be a purely tropical one, its offshoots seldom extending above thirty degrees from the equator. With Chinese, exceptional analogies have been found, but these are either doubtful or accidental.

A fit sequel to this present paper (I suggest) will be found in Appendix II., where I have compared the languages of the Malayan Archipelago with that of Samoa or the Navigators Islands in Polynesia. I am enabled to do this by the recent publication of a Samoan Grammar and Dictionary, by the Rev. George Pratt, edited by the Rev. S. J. Whitnee, F.R.G.S. This portion of the subject is the more interesting as Samoa is the reputed Hawaiki * of the Maori.

It will be observed by the comparative vocabulary given in Appendix II, that all objects known in the Samoan Islands and the Malay Archipelago are, almost without exception, represented radically by the same words in either region. Objects unknown to the Polynesian as a matter of course are not represented—such as deer, gold, honey, iron, monkey, etc. And the locality where these Malayo-Polynesian affinities exist is not difficult to point out, viz., the Moluccas; thus of the 94 analogies represented, 24 are found in Ceram, 11 in Matabello, 7 in Borou, 7 in Amboyna, 7 in Sula Islands, 7 in Sangair, 6 in Celebes †. Again of the 114 words contained in the whole list only 26 are Malay. Thus on our premises we would infer that the population of Samoa was not directly derived from Malaya (Sumatra or Malay Peninsula) but from the Moluccas. In other words, in the diffusion of the blood of the Barata race, while Malaya may have acted as a vein or path—the Moluccas acted as a gland or stepping-stone.

For this purpose no region could be more appropriate than the Moluccas, for here were the spices and rare birds so attractive to commerce, to be found. From time immemorial here would be the great rendezvous of Barat, that is, *western* adventurers and conquerers, and from whence their more enterprising spirits would venture further east. Thus, if it be said that the Moluccas were the stepping-stone to Barata emigration, so also is it said that Samoa was the focus of Polynesian dispersion.

That we have not found a language in the Malayan Archipelago completely analogous to Samoan is consistent with our theory—for in the preceding part of our paper neither has there been found a language in Hindustan completely consistent with the Malagas-malayo-polynesian dialects. In both cases, however, the unquestionable evidence of root or fossil

* Query; Hawa-iki, literally small harbour, or coral reef opening.

† See Appendix III.

words is there, which gives unerring witness of community of blood and race. The fossil words preserved in the Moluccas, not in the tongues of the great races of Java, Waju, or Malaya, but in those obscure remnants whose remoteness or inaccessibility have protected them from the deleting waves of successive migrations.

Appendix I.

Arrow.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			*zana*tsipikia	panah	pere
Asia ..	Indo-China	Shan	pen	pen	..
	South India	Telugu	ba*na*mu	ba*na*mu	
	N.E. Bengal	Garo	..	..	phe-e
	Bay of Bengal	Great Nicobar	..	..	en*phæ* hnje
Africa ..	East Coast	Mozambique	..	..	ntere
	East Central	Yao	mpamba	mpamba	..
	do.	Kimasai	*embai*	*embai*	..
	W. & Central	Mandingo	*ben*yo	*ben*yo	..
	do.	Bambarra	bien	bien	..
	do.	Fanti & Ashanti	*eben*	*eben*	..
Malay Archipelago ..	Javanese	..	pannah	pannah	..
Polynesia ..	Tongan	..	fanna	fanna	..
	Hawaiian	..	he pua *pana*	he pua-*pana*	..
Australia ..	..	..	..	..	..

Bird.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			vorona	burong	manu
Asia ..	Nepal	Limbu	bu	bu	..
	East of Bengal	Mithan Naga	o	o	..
	do.	Namsang Naga	vo	vo	..
	do.	Singpho	wu	wu	..
	Indo-China	Siamese	..	..	nok
	do.	Ahom	..	..	nuktu
	do.	Khamti	..	..	nok
	do.	Laos	..	..	nok
Africa ..	..	..	..	..	..
Malay Archipelago ..	Javanese	..	..	..	manok
	Other islands	..	..	..	manoko, manu, manui, manu-manu, manuti, manik, mano, manuo, manu-wan, etc.
	South Celebes	Salayer	burung	burung	..
	Amboyna	Batu merah	burung	burung	..
Polynesia ..	Fijian	..	..	..	manu-manu
	Samoan	..	..	..	manu
	Tongan	..	..	..	manu
	Hawaiian	..	..	..	he manu
Australia ..	..	..	..	..	..

Blood.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			ra	dara	toto
Asia ..	Tibeto-China	Takpa [ten	kh*ra*	kh*ra*	..
	do.	Tibetan, writ-	kh*rag*	kh*rag*	..
	Nepal	Pakhya	*ragat*	*ragat*	..
	East Nepal	Rodong	haa	haa	..
	do.	Waling	ha	ha	..
	Nepal	Darhi	*ragat*	*ragat*	..
	do.	Denwar	*ra*ktai	*ra*ktai	..
	do.	Kuswar	*ra*kti	*ra*kti	..
	Bay of Bengal	Nancowry	wa	wa	..
	do.	Car Nicobar	*ma*ham	*ma*ham	..
Africa ..	W. & Central	Walof	..	*derre*te	..
Malay Archipelago ..	Various Islands	..	orah, rara, daha, dugu, poha, lala, raha, yan lalai lalah, laia, lawa, lahim, lasin, larah, lemoh, lahah, etc.	the same	..
Polynesia ..	Fijian	..	dra	dra	..
	Samoan	..	..	..	toto
	Tongan	..	..	..	tawto
	Hawaiian	..	..	..	he koko
Australia ..	..	..	..	..	..

Bone.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			taolana	tolan	iwi
Asia ..	Nepal	Newar	..	..	kwe
	Indo-China	Sgau-Karen	..	..	khi
	do.	Pwo-Karen	..	..	khwi
	Chinese	Shanghai	..	..	kweh-den
	Bay of Bengal	Teressa	kolran	kolran	..
Africa ..	..	..	..	..	..
Malay Archipelago ..	Javanese	..	balong	balong	..
	N. Celebes	Bolang hitam	tula	tula	..
	Sula Islands	..	..	..	hoi
Polynesia ..	Fijian	..	..	..	*sui*-na
	Samoan	..	..	..	ivi
	Tongan	..	..	..	hui
	Hawaiian	..	..	..	iwi
Australia ..	..	..	..	..	..

Dog.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			amboa	anjing	kuri
Asia ..	Nepal	Murmi	..	n*angi*	..
	Tibeto-China	Gyami	..	..	kou
	Nepal	Dungmali	..	..	*kuti*-ma
	do.	Chepang	..	..	kui
	East Bengal	Tablung Naga	..	..	kui
	Indo-China	Burma	..	..	khwe
	do.	Khyeng	..	..	ui
	do.	Sak	..	..	ku
	Bay of Bengal	Nancowry	ahm	..	..

Dog—continued.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
Africa ..	East Coast	Swahili	mbwa	..	..
	do.	Inhambane & Sofala	imbua	..	..
	do.	Cap Delgado	umboa	..	..
	do.	Shambala	..	..	kuli
	East Central	Yao	'mbwa	..	..
	West Coast	Haussa	..	..	kari
	South	Kafir	..	inja	..
Malay Archipelago ..	..	..	..	..	..
Polynesia ..	Fijian	..	..	..	koli
	Samoan	..	..	..	uli
	Tongan	..	..	..	guli
Australia ..	..	..	..	..	..

Ear.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			sofina	telinga	taringa
			talinhe	..	..
Asia ..	East Bengal	Tengsa Naga	telannu	telannu	telanna
	Khasi & Jynteah Hills	Amwee	tarang	tarang	tarang
	do.	Lakadong	tarang	tarang	tarang
	Bay of Bengal	Shobœng	..	gna	gna
Africa ..	East Central	Kimasai	..	ingia	ingia
	Western	Mandingo	tule	..	..
	do.	Sussu	tule	..	..
	W. & Central	Mandingo	tulo, tula	..	..
	do.	Bambarra	tlo	..	..
	East	Masai	..	ingia	ingia
Malay Archipelago ..	Various isles	..	talinga, toli, linganani, ngan, terina, terena, tenaan, etc.	telinga, telilan, tinget terina, terina-mo, terinan	telingan, telina, telinawa, likan, teninare
Polynesia ..	Fijian	..	daliga-na	daliga-na	daliga-na
	Samoan	..	taliga	taliga	taliga
	Tongan	..	telinga	telinga	telinga
Australia ..	..	..	..	..	..

Earth.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			tany	tana	one-one
Asia ..	Indo-China	Thoungh-thu	ham-*tan*	ham-*tan*	..
	do.	Siamese	tein	tein	..
	Central India	Khond	tana	tana	..
	N. E. Bengal	Dhimal	..	..	bh*onoi*
	Central India	Kol	..	..	ote
	Bay of Bengal	Teressa	*matah* œt	*matah* œt	..
	do.	Shobœng	..	..	h*o*ng
Africa ..	..	..	..	..	..
Malay Archipelago ..	..	..	..	..	..
Polynesia ..	..	..	..	..	..
Australia ..	..	..	..	..	..

Egg.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			atody	telor	hua
Asia ..	East of Bengal	Singpho	udi	..	..
	Indo-China	Burma	..	..	..
Africa ..	Western	Kossa	..	tegoli	..
Malay Archipelago ..	Various Islands	..	ontolo, tanar, metelo, telon, munteloa, teruni, tin, tolor, atulu,	natu, tuloi, telo, toli, tero, letuli, tolin, tolnin, telli untello	..
Polynesia ..	Samoan	..	..	..	fua
	Tongan	..	..	..	foi
	Hawaiian	..	..	..	he hua
Australia ..	..	..	..	..	..

Eye.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			maso	mata	kanohi
Asia ..	East Nepal	Dumi	mas	mas	..
	East of Bengal	Munipuri	mit	mit	..
	Indo-China	Shan	matta	matta	..
	do.	Annam	mat	mat	..
	Central India	Ho (Kol)	met	met	..
	do.	Kuri	met	met	..
	..	Brahui	..	..	khan
	Tibeto-China	Thochu	..	..	kan
	Central India	Uraon	..	..	khan
	do.	Khond	..	..	kannuka
	Southern do.	Telugu	..	..	kannu
	do.	Badaga	..	..	kannu
	Khasi & Jynteah Hills	Khasi	..	khy*mat*	..
	do.	Synteng	..	khy*mat*	..
	do.	Battoa	..	ka-khy*mat*	..
	do.	Amwee	..	ka-*mat*	..
	do.	Lakadong	..	ka-*mat*	..
	Bay of Bengal	Nancowry and Car Nicobar	ol*mat*	ol*mat*	..
	do.	Teressa	e*mat*	e*mat*	..
	do.	Shobœng	hin*mat*	hin*mat*	..
Africa ..	East Coast	Swahili	macho, mato	mato	..
	do.	Inhambane, Tette, Sena, Cap Delgado, Maravi	mazo	..	..
	do.	Sofala	messo	..	..
	do.	Quillimane and Mosambique	..	meto	..
	do.	Shambala	mesho	mesho	..
	East Central	Yao	meso	meso	..
	Western	Kongo	mesu	mesu	..
	do.	Benin	me-is	me-is	..
	South	Kafir	amaso	..	..
			..	..	..
Malay Archipelago ..	Various isles	..	moto, mata, hama, raman, ramani, matara, mata-mo, mata-colo, matan, matara, mata-nina, matada, matin, tun, mut, moorba		..

Eye—continued.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
Polynesia ..	Fijian	..	mata	mata	..
	Samoan	..	mata	mata	..
	Tongan	..	mata	mata	..
	Hawaiian	..	maka	maka	..
Australia ..	..	..	..	..	..

Fire.

			afo	api	ahi
Asia ..	China	Nankin	ho	..	..
	do.	Canton	fo	..	..
	Nepal	Kuswar	..	aghi	aghi
	do.	Tharu	..	agi	agi
	East of Bengal	Tablung Naga	..	ah	a'h
	Indo-China	Shan	..	hpihn	hpihn
	do.	Siamese	fai	fai	fai
	do.	Laos	fai	fai	fai
	Japan	Japun	..	..	hi
Africa ..	Western	Fulah	ofe	ofe	ofe
Malay Archipelago ..	Various islands	..	wha, api, ahu, afo, aow, hao, aousa, hao, yafo, yaf, wahan, a'if, efi, yaf, lap, yap, etc.		
Polynesia ..	Samoan	..	afi	afi	afi
	Tongan	..	afi	afi	afi
	Hawaiian	..	he ahi	he ahi	he ahi
Australia ..	N. S. Wales	Kamilaroi	wi	wi	wi

Fish.

			lo*aka*	ikan	ika
Asia ..	Nepal	Chepang	nga	nga	nga
	East of Bengal	Namsang Naga	nga	nga	nga
	Indo-China	Burma	nga	nga	nga
	do.	Talain v Mon	ka	ka	ka
	do.	Annam	ka	ka	ka
	Bay of Bengal	Nancowry and Car Nicobar	ka	ka	ka
	do.	Teressa	kha	kha	kha
	do.	Shobœng	gna	gna	gna
Africa ..	East Coast	Swahili	..	sam*aki*	sam*aki*
	Western	Bullom & Appa	iu	iu	iu
	do.	Karaba	i-iak	i-iak	i-iak
	West and Central	Ako, Eyo, Yabo or Yarriba	eja, eya	eja, eya	eja, eya
	do.	Nufi	nika, yika	nika, yika	nika, yika
	South	Kafir	..	inklanzi	inklanzi
Malay Archipelago ..	Various Islands	..	iwa, ikani, kina, kena, iani, ikan, ikiani, nyan ian, iyan, yano, iem, ein, deiah		
Polynesia ..	Fijian	..	ika	ika	ika
	Samoan	..	ia	ia	ia
	Tongan	..	ika	ika	ika
	Hawaiian	..	he ia	he ia	he ia
Australia ..	..	..	..	..	..

Flower.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			vony	bunga	pua
Asia ..	Nepal	Sunwar	phu	phu	phu
	East Nepal	Rodong	bungna	bungna	bungna
	do.	Thulungya	bungma	bungma	bungma
	do.	Khaling	pungma	pungma	pungma
	Central India	Santali	buha	buha	buha
	do.	Gayeti	pungar	pungar	pungar
	South'rn India	Tamil, Tuluva	pu	pu	pu
Africa ..	East Coast..	Swahili	..	..	ua
	East Central	Yao	..	..	ndua
	Central	Haussa	..	..	fureh
Malay Archi-pelago ..	Various Islands	..	bunga, obunga, burani, mnuru		
Polynesia ..	Samoan	..	fuga	fuga	fuga
	Tongan	..	fua	fua	fua
	Hawaiian	..	he pua	he pua	he pua
Australia ..	..	..	..	..	..

Foot.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			tongon*	kaki	wae-wae
Asia ..	China	Amoy	..	k'a	..
	Indo-China	Khyong & Shou	..	kako	..
	Khasi & Jynteah Hills	Battoa	..	*kaki*-jat	..
	do.	Khasi	..	*ki*-jat	..
	do.	Synteng	..	*ki*-jat	..
Africa ..	..	..	..	..	..
Malay Archi-pelago ..	Various islands	..	..	..	oei, yiei, ai, yai, oweda, mat*wey*
Polynesia ..	Fijian	..	..	..	yava-na
	Samoan	..	..	..	vae
	Tongan	..	..	..	vae
	Hawaiian	..	..	..	he wae wae
Australia ..	..	..	..	..	..

* *tangan,* hand in Malay.

Hair.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			volo	bulu, rambut	huru
Asia ..	Tibeto-China	Takpa	pu	pu	pu
	Khasi & Jynteah Hills	Lakadong	usu	usu	usu
Africa ..	East Coast	Inhambane	mud*udu*	mud*udu*,	mud*udu*
	East Central	Yao	..	umbo	..
Malay Archi-pelago ..	Various islands	..	balwa, uhu, uta, wooko, utan, buloni, folo, olofolo, hutu, hua, rewohoh, ulvu, ulufuim, hue, ua, wultafun		
Polynesia ..	Fijian	..	vulua	vulua	vulua
	Samoan	..	fulu-fulu	fulu-fulu	fulu-fulu
	Tongan	..	lau-ulu	lau-ulu	lau-ulu
	Hawaiian	..	ka lauoho	ka lau oho	ka lau oho
Australia ..	N. S. Wales	Wailwun	wulla	wulla	wulla

Hand.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			tanana	tangan	(ringa-ringa) kutanga
Asia ..	Tibeto-China	Tibetan	lango	lango	lango
	Nepal	Serpa	lango	lango	lango
	Khasi & Jynteah Hills	Amwee	ka *ta*	ka *ta*	*kata*
Africa ..	East Coast	Swahili	ki*tanga**	ki*tanga*	ki*tanga*
	Central	Haussa	*hanu*	*hanu*	*hanu*
Malay Archipelago ..	Java, Baju	..	tangan	tangan	tangan
Australia ..	Victoria	Witaoro	mu*nangan*	mu*nangan*	mu*nangan*

* Palm of hand.

Head.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			loha	ulu, kapala	upuko
Asia ..	Indo-China	Khyeng v Shou	lu	lu	..
	do.	Mru v Toung	lu	lu	..
	do.	Ahom	ru	ru	..
	Tibeto-China	Thochu	..	kapat	..
	Nepal	Bhramu	..	ka-pa	..
	Central India	Kolami	..	kupal	..
	do.	Kol (Sing bhum)	bu	bu	bu
	do.	Santali	..	..	buho
	do.	Bhumij	..	..	buho
	Khasi & Jynteah Hills	Amwee	..	kakhlia	..
	do.	Lakadong	..	kakhlan	..
	Bay of Bengal	Shobœng	..	..	po
Africa ..	East Coast	Quellimane	..	*muru*	..
	Western	Moko	lo	lo	..
Malay Archipelago ..	S. Celebes	Bouton	..	..	ubaku
	Ceram	Ahtiago	..	..	oyuko
	Various Islands	..	ulu, urie, olum, ulun fatu, olun olimbukoi, uruka, ulura, uru, ulumo, yulim, ulukatim, lunini, ulure, aluda ulin		..
Polynesia ..	Fijian	..	ulu-na	ulu-na	..
	Samoan	..	ulu	ulu	..
	Tongan	..	ulu	ulu	..
	Hawaiian	..	..	..	ke *pu*
Australia ..	..	..	..	..	..

Hog.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			kisoa, lambo	babi	poaka
Asia ..	Nepal	Darhi	su-er	..	..
	do.	Tharu	suwar	..	..
	Central India	Uraon, etc.	kis	..	..
	Southern India	Tamil (anc)	keshal	..	..
	Nepal	Rungchenbung, etc.	..	ba	..
	do.	Sangpang	..	bha	..
	Tibeto-China	Tibet (spoken)	..	..	phak-pa

Hog—continued.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
Asia	Nepal	Limbu	..	..	phag
	do.	Chingtangya	..	..	phak
	do.	Vayu	..	..	pog, pok
	N. E. India	Bhutani v Lhopa	..	..	phagpo
Africa ..	East Central	Yao	mbango	..	..
	West Coast	Fulah	..	baba	..
	W. & Central	Bambarra	..	fali	..
	do.	Fanti & Ashanti	..	..	prako
Malay Archipelago	Various Islands	..	..	bahi, balu, bawi fafi babue, fafu bawu, boh, fafuim, boia, faf, boh	..
Polynesia ..	Fijian	..	sara	..	vuaka
	Samoan	..	..	..	pua'a
	Tongan	..	..	..	boaka
	Hawaiian	..	..	..	he puaa
Australia ..	..	..	..	..	..

Leaf.

			ravina	daun	rau
Asia ..	Nepal	Gurung	..	lau	lau
	do	Newar	..	hau	hau
	Indo-China	Ahom	..	bou	bou
	do	Khamti	..	mau	mau
Africa ..	W. & Central	Fanti and Ashanti	..	at*au*	at*au*
Malay Archipelago ..	Various Islands	..	..	tawana, taha, daun, ailaw, laun, laini, lan, idun	
Polynesia ..	Fijian	..	..	drau-na	drau-na
	Samoan	..	..	lau	lau
	Hawaiian	..	..	he lau	he lau
Australia ..	..	..	..	..	..

Light.

			maivana	trang	ao
Asia ..	E. of Bengal	Mithan Naga	..	*rang*ai	..
	do	Namsang Naga	..	*rang*vo	..
	Indo-China	Burman	..	lang	..
	N.E. Bengal	Lepcha (Sikkim)	..	..	aom
Africa ..	East Coast	Swahili	..	*anga*	..
Polynesia ..	Samoan	..	mala malama	..	..
	Hawaiian	..	mala malama	..	he ao
Australia ..	..	..	..	..	..

Moon.

			volana	bulan	marama
Asia ..	Nepal	Serpa	oula	oula	..
	Indo-China	Mru v Toung	pula	pula	..

Moon—continued.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
Africa ..	W. & Central	Ibu	oua	oua	..
Malay Archipelago ..	Various Islands	..	wulan, bula, bulan, balrang, wura, buran, burang, bulani, fhulan, bular, ora, hulanita, hoolan, hulani, phulan, wulani, wuan		..
Polynesia ..	Fijian	..	vula	vula	..
Australia ..	..	..	..	..	..

Mouth.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			vava	mulut	mangai, waha
Asia ..	Nepal	Lohorong	ya	..	ya
	Central India	Yerukala	vayi	..	vayi
	Southern India	Tamil	vay	..	vay
	do.	Malayalma	vaya	..	vaya
	do.	Karnatika	bayi	..	bayi
	do.	Toduva	payi	..	payi
	do.	Kota	vai	..	vai
	do.	Kurumba	bai	..	bai
	Nepal	Newar	..	mhutu	..
	do.	Yakha	..	*mula*phu	..
	do.	Kuswar	..	muhu	..
	Bay of Bengal	Teressa	..	..	monoi
Africa ..	East Africa	Swahili	kin*wa*	..	kin*wa*
	do.	Sofala Tete & Sena	..	muromo	..
	do.	Quellimane	..	mulomo	..
	do.	Shambala	..	mulomo*	..
	do.	do.	kan*wa*	..	kan*wa*
	East Central	Yao	kam*wa*	..	kam*wa*
	do.	Kimasai	..	eng-*uduk*	..
	South	Kafir	..	umlomo	..
Malay Archipelago ..	South Celebes	Salayer	bawa	..	bawa
	Baju		boah	..	boah
Polynesia ..	Hawaiian	..	he waha	..	he waha
Australia ..	N. W. Coast	..	..	mulu	..

* Lip.

Night.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			alina	malam	po, kengo
Asia ..	China	Shanghai	yali	..	..
	Central India	Naikude	ale	..	..
	do.	Tamil (anc)	al	al	..
Africa ..	..	..	..	..	..
Malay Archipelago ..	Amboyna	Batu-merah	hulanita	..	..
	Saparua	..	..	..	*potu*
Polynesia ..	Fijian	..	..	..	*bogi*
	Samoan	..	..	..	po
	Tongan	..	..	..	bo-uli
	Hawaiian	..	..	..	po
Australia ..	..	..	..	..	..

Rain.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			ranonorana	ujan	ua
Asia ..	..	..	..	..	..
Africa ..	East Africa	Swahili	..	*mvua*	*mvua*
	do.	Lourenzo Marques	..	inf*ula*	inf*ula*
	do.	Inhambane	..	*vula*	*vula*
	do.	Sofala	..	umv*ura*	umv*ura*
	do.	Tete	..	*vura*	*vura*
	do.	Sena	..	ku-b*oumba*	ku-b*oumba*
	do.	Mosambique	..	ip-p*ula*	ip-p*ula*
	do.	Cap Delgado	..	(m) *vula*	*vula*
	do.	Maravi	..	*vura*	*vura*
	do.	Shambala	..	*fula*	*fula*
	East Central	Yao	..	ula	ula
	Central	Haussa	..	*rua*	*rua*
	South	Kafir	..	imv*ula*	imvv*ula*
Malay Archipelago ..	Various islands	..	..	hudan, oha, urong, huya, ulani, ulah, ulan, hura, hulan, hulani, huran, ulane, ulani, ulan, uan, udama, hurani, golim, huran	
Polynesia ..	Fijian	..	..	uca	uca
	Samoan	..	..	ua	ua
	Tongan	..	..	uha	uha
	Hawaiian	..	..	he ua	he ua
Australia ..	..	..	..	..	..

Road.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			lalambe	jalan	ara
Asia ..	Tibeto-China	Tibet (written)	lam	..	..
	Nepal	Serpa and two others	lam	..	..
	East Nepal	Kirante and 14 others	lam	..	..
	North Bengal	Bhutani and 4 others	lam	..	..
	East Bengal	Mithan Naga and 2 others	lam	..	..
	do.	Abor Miri	lambeü	..	..
	Indo-China	Burman and 5 others	lam	..	.. ..
	Tibeto-China	Tibet (spoken)	..	*lani*	
	Nepal	Newar	..	lon	..
	Indo-China	Burman (spoken)	..	lan	..
	Tibeto-China	Manyak	..	..	rah
	Nepal	Sunwar	..	..	la
	Central India	Santali	..	..	har
	do.	Mundala	..	..	horah
Africa ..	East Central	Yao	..	..	pet*ala*
Malay Archipalago ..	Various Islands	..	dara, lalan, dalren, lora, dalin, aya, lalani, lolan, lahan, lalano, latina, lalim, lāān, laran, lagain, lelin, lalan		
Polynesia ..	Fijian	..	sala	sala	sala
	Samoan	..	ala	ala	ala
	Tongan	..	hala	hala	hala
	Hawaiin	..	he *ala* nui	he *ala* nui	he *ala* nui
Australia ..	..	..	..	..	..

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			Sky.		
			lanitra	langit	rangi
Asia ..	Nepal	Sunwar	*sarangi*	*sarangi*	sa-*rangi*
	do.	Kuswar	sa-*rang*	sa-*rang*	sa-*rang*
	Central India	Ragmahali	sa-*range*	sa-*range*	sa-*range*
Africa ..	..	..	..	..	..
Malay Archipelago ..	..	..	..	..	..
Polynesia ..	Fijian	..	lagi	lagi	lagi
	Samoan	..	lagi	lagi	lagi
	Hawaiian	..	ka-*lani*	ka *lani*	ka-*lani*
Australia ..	..	..	..	..	..
			Star.		
			kintana	bintang	whetu
Asia ..	N. E. Bengal	Garo	laitan	laitan	..
	Central India	Uraon	binka	binka	..
	South'rn India	Toda	min	min	..
Africa ..	..	..	..	..	..
Malay Archipelago ..	Various islands	..	lintang, bintang, bituy, bituin, fatui, teon. toin, toen		
Polynesia ..	Samoan	..	..	..	fetu
	Tongan	..	..	..	fetu
Australia ..	..	..	..	..	..
			Sun.		
			maso-andro	mata-hari	ra, komaru
Asia ..	Indo-China	Annam	..	mata-troi	..
	Tibeto-China	Sokpa	..	..	*nara*
	Nepal	Sunwar	..	..	na
Africa ..	Central	Haussa	..	..	*rana*
Malay Archipelago ..	Various Islands	..	mata-alo, mata-rou mata-lon		..
Polynesia ..	Fijian	..	mata ni-siga	mata ni-siga	..
	Samoan	..	..	..	la
	Tongan	..	..	..	laa
	Hawaiian	..	..	..	la
Australia ..	..	..	..	..	..
			Tongue.		
			lila	lida	arero
Asia ..	Khasi & Jynteah Hills	Battoa	u-thy*lliad*	u-thy*lliad*	..
	do	Amwee	u-kh*lid*	u-kh*lid*	..
	do	Lakadong	u-kh*liad*	u-kh*liad*	..
	Bay of Bengal	Nancowry	*geletak*	*geletak*	..
Africa ..	East Coast	Quellimane	*lilimi*	*lilimi*	..
	do	Shambala	lu*limi*	lu*limi*	..
	East Central	Yao	lu*limi*	lu*limi*	..
	South	Kafir	ul*wimi*	ul*wimi*	..

Tongue—continued.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
Malay Archipelago ..	Various Islands	..	ilat, lilah, dila, melin, ninum, delah		..
	Mysol	..	..	..	aran
Polynesia ..	Samoan	..	..	..	alelo
	Tongan	..	..	..	elelo
	Hawaiian	..	..	..	ka elelo
Australia ..	..	..	..	..	..

Tooth.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			nifi, nifo	gigi	niho, rei
Asia ..	Nepal	Thaksya	..	*gyo*	..
	East Nepal	Chourasya	..	*ginnso*	..
	Central India	Gadaba	..	*ginna*	..
Africa ..	East Coast	Swahili	jino	..	jino
	do.	Shambala	zino	..	zino
	East Central	Yao	lino	..	lino
	West Coast	Mandingo	..	gi	..
	W. & Central	Filatah, Filani or Fulah	niye	..	niye
	do.	Bambarra	nye	..	nye
	South	Kafir	izinyo	..	izinyo
Malay Archipelago ..	Various Islands	..	nihi, nisim, nisi nisinen, niki, nio, nisi-mo, nifan nifoa, nifin	..	nihi, nisim, nisi, nisinen, niki, nio, nisimo, nifan, nifoa, nifin
	do.	..	..	gigi, ngisi, isi	..
Polynesia ..	Samoan	..	nifo	..	nifo
	Tongan	..	nifo	..	nifo
	Hawaiian	..	niho	..	niho
Australia ..	..	..	..	..	..

Tree.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			hazo	pun, kaiu, [poko	rakau
Asia ..	Tibeto-China	Thochu	*gwozosi*	..	..
	N.E. Bengal	Garo	..	pan	..
	E. of Bengal	Mithan Naga	..	pan	..
	..	Singpho	..	phun	..
	Indo-Persia	Brahui	..	..	da*rakht*
	Bay of Bengal	Teressa	..	..	..
Africa ..	..	..	..	..	..
Polynesia ..	Samoan	..	..	..	la' au
	Hawaiian	..	..	..	he laau
Australia ..	..	..	..	..	..

Water.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
			rano	ayer	wai
Asia ..	Tibeto-China	Horpa	hrah	..	..
	do.	Manyak	..	dyah	..
	Nepal	Bhramu	..	awa	awa
	Central India	Gondi	..	yer	..

Water—continued.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
Asia ..	Central India	Gayeti	..	yer	..
	do.	Rutluk	..	er	..
	do.	Naikude	..	ir	..
	do.	Kolami	..	ir	..
	do.	Madi	..	er	..
	do.	Madea	..	per	..
	Southern India	Tamil (mod.) and 4 others	..	nir	..
	East Nepal	Sang Pang	..	..	wa
Africa ..	East Coast	Swahili	..	*maji*	*maji*
	do.	Shambola	..	*mazi*	*mazi*
	East Central	Yao	..	mesi	mesi
	Western	Sussu	..	i-e	i-e
	do.	Pessa	..	iah	iah
	South	Kafir	..	amanzi	..
Malay Archipelago ..	Various Islands	..	..	aer, akei, aki, wai, waili, waiyr, weyer, weyl, waeli, welo, wai-im, arr. wehi, wayr	
	Javanese	..	*banyu*	..	..
	S. Celebes	Bouton	*manu*	..	..
Polynesia ..	Fijian	..	..	wai	wai
	Samoan	..	..	vai	vai
	Tongan	..	..	vai	vai
	Hawaiian	..	..	wai	wai
Australia ..	..	..	..	..	..

Yam.

			ovi	ubi	uwhi-kaho
Asia ..	..	..	..	..	..
Africa ..	..	..	..	..	..
Polynesia ..	Fijian	..	uvi	uvi	uvi
	Samoan	..	ufi	ufi	ufi
	Hawaiian	..	uhi	uhi	uhi
Australia ..	..	..	..	..	..

Hot.

			ma*fana*	panas, hangat	wera
Asia ..	South'rn India	Tamil (anc.)	..	..	veya
Africa ..	..	..	..	..	..
Malay Archipelago ..	Various Islands	..	panas, mopani, bahaha, bafanat, mofanas, benis		panas
	Mysol	..	..	..	pela
Polynesia ..	Samoan	..	..	..	vevela
	Tongan	..	..	..	vela
	Hawaiian	..	..	..	wela
Australia ..	..	..	..	..	..

Raw.

			manta	manta	mata
Asia ..	East of Bengal	Nowgong Naga	matok	matok	matok
	Bay of Bengal	Teressa	mahaa	mahaa	mahaa
Africa ..	..	..	..	..	..

Raw—continued.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
Polynesia ..	Samoan	..	mata	mata	mata
	Hawaiian	..	maka	maka	maka
Australia ..	..	..	..	..	..
			Red.		
			mena	mera	whero
Asia ..	South'rn India	Telugu	era	era	yerupu
	Central India	Naikude	..	..	yerodi
	do.	Kolami	..	..	yerrodi
Africa ..	..	..	..	..	..
Malay Archipelago ..	Various Islands	..	merai, maramutah, mia, miha, mehani, meranati, merah.		
Australia ..	..	..	..	..	..
			Ripe.		
			*masa*ka	masa	maoa
Asia ..	Nepal	Sunwar	miso	miso	miso
Africa ..	..	..	..	..	..
Malay Archipelago ..	..	..	..	..	..
Polynesia ..	..	..	..	..	..
Australia ..	..	..	..	..	..
			Small.		
			keli	kichi	riki, iti, nohi nohi
Asia ..	Tibeto-China	Gyarung	..	kachai	..
	East Nepal	Thulungya	..	kichem	..
	do.	Bahingya	..	kachim	..
	do.	Lambichong	..	*michi*yuk	..
	North Bengal	Lepcha (Sikkim)	..	achim	..
	E. of Bengal	Singpho	..	katsi	..
	Indo-China	Ahom	..	..	noi
	Bay of Bengal	Andaman	*kiti*marda	*kiti*marda	*kiti*-marda
Africa ..	..	..	..	..	..
Malay Archipelago ..	..	..	..	..	..
Polynesia ..	Samoan	..	..	..	laiti-*iti*
	Hawaiian	..	..	..	palanai-iki
Australia ..	..	..	..	..	..
			Come.		
			avi	mari	mai
Asia ..	China	Nankin, Pekin, Amoy	lai	lai	lai
	do.	Canton	loi	loi	loi
	Tibeto-China	Thochu	hai	hai	hai
	Indo-China	Sgau-karen	hai	hai	hai

Come—continued.

Region.	Country.	District.	Malagasi.	Malay.	Maori.
Asia ..	Indo-China	Annam	lai	lai	lai
	do.	Siam, Ahom, Khamti, Laos	..	ma	ma
	Central India	Yerukala	va	..	..
	South'rn India	Tamil	va	..	..
	do.	Toda, Kota	it va	..	..
	do.	Malabar	va	..	..
Africa ..	..	..	..	..	..
Malay Archipelago ..	Various Islands	..	marein, maive, maika, aripa, dumahi, maranih, mai, omai, ikomai, gumaho, uimai, oimai, omai, alowei, gomari, jogmah		
Polynesia ..	Fijian	..	lako-*mai*	lako-*mai*	lako-*mai*
	Tongan	..	hau-*mai*	hau-*mai*	hau-*mai*
	Hawaiian	..	e hele *mai*	e hele *mai*	e hele *mai*
Australia ..	..	..	..	..	..
			Five.		
			dimi, limi	lima	rima
Asia ..	..	..	..	..	..
Africa ..	..	..	..	..	..
Malay Archipelago ..	Various Islands	..	limanu, rima, delima, leplim, rima, enlima, lim, nima, lim		
Polynesia ..	Fijian	..	lima	lima	lima
	Samoan	..	e-lima	e-lima	elima
	Tongan	..	nima	nima	nima
	Hawaiian	..	elima	elima	elima
Australia ..	..	..	..	..	..
			Six.		
			enina, oné	anam	ono
Asia ..	..	..	..	..	..
Africa ..	..	..	..	..	..
Malay Archipelago ..	..	..	nanam, nanamo, unam, num, onomo, kanum, annuh, gane, ne, noh, nena nöo, noöh, nome, noi, num, ennoi, wonen, lomi, onam, nem, onum, nam		
Polynesia ..	Fijian	..	e-ono	e-ono	e-ono
	Samoan	..	ono	ono	ono
	Tongan	..	whaine	whaine	whaine
	Hawaiian	..	eono	eono	eono
Australia ..	..	..	..	..	..
			Seven.		
			fito	tuju	whitu
Asia ..	Central India	Gondi	yetu	..	yetu
	do.	Madi	yedu	..	yedu
	do.	Kuri	yeiku	..	yeiku
	do.	Gadaba	yedu	..	yedu
	do.	Yerukala	yegu	..	yegu
	South'rn India	Telugu	yedu	..	yedu
	do.	Karnataka	yelu	..	yelu
	do.	Kurgi	elu	..	elu
	East Nepal	Balali	..	nuji	..
Africa ..	..	..	..	..	..

Seven—continued.

REGION.	COUNTRY.	DISTRICT.	MALAGASI.	MALAY.	MAORI.
Malay Archipelago ..	..	..	pitu, pituano kapitu, gapitu hito, pito, itu itua, hitu, witu, fitu, fit fiti, itu, tit	..	pitu, pituano, kapitu, gapitu, hito, pito, ito itua, hitu, witu fitu, fit, fiti, itu, tit
	S. Celebes	Salayu	..	tujoh	..
	Baju	..	..	tujoh	..
Polynesia ..	Fijian	..	e-vitu	..	e-vitu
	Samoan	..	fitu	..	fitu
	Tongan	..	fidda	..	fidda
	Hawaiian	..	ahiku	..	ahiku
Australia ..	..	..	..	..	..

Eight.

REGION.	COUNTRY.	DISTRICT.	MALAGASI.	MALAY.	MAORI.
Asia ..	Central India	Yerukala	valo, varlo, vattu	delapan ..	waru vattu
Africa ..	..	..	..	..	..
Malay Archipelago ..	Various Islands	..	wola, veluano walru waro walu waru walua wagu wol, enwal alu, allu	..	wola, veluano, walru, waro walu waru walua wagu wol, enwol alu, allu
	Baju	..	..	dolapan	..
Polynesia ..	Fijian	..	walu	..	walu
	Samoan	..	valu	..	valu
	Tongan	..	varu	..	varu
	Hawaiian	..	awalu	..	awalu
Australia ..	..	..	..	..	..

Nine.

REGION.	COUNTRY.	DISTRICT.	MALAGASI.	MALAY.	MAORI.
Asia ..	Indo-China	Sgau-Karem	sivi, siva kwi, hkwi	sambilang	iwa, iva kwi, hkwi
	do	Pwo-Karen	kwi	..	kwi
Africa ..	..	..	..	..	..
Malay Archipelago ..	Various Islands	..	sioanu, sio kasiow, siwa chia, sia, ensiwa siwer, si, sin	..	sioanu, sio kasiow, siwa chia, sia, ensiwa siwer, si, sin
	Baju	..	..	sambilan	..
Polynesia ..	Fijian	..	ciwa	..	ciwa
	Samoan	..	iva	..	iva
	Tongan	..	hioa	..	hioa
	Hawaiian	..	eiwa	..	eiwa
Australia ..	..	..	..	..	..

APPENDIX II.

	ENGLISH.	SAMOAN.	—
1	Black	uliuli	*wulin*, Langowan, North Celebes
2	Fire	afi	*afu*, Amblaw; *aif*, Gah, Ceram; *efi*, Matabella; *yaf*, Teor; *yap*, Mysol
3	Large	latele	*leleh*, Matabello
4	Nose	isu	*iru*, Lariki; *inu*, Vaiqueno, East Timor
5	Small	laitiiti	*kiiti*, Wahai, Ceram
6	Tongue	alelo	*ela*, Sasak, Lombok; *kelo*, Matabello
7	Tooth	nifo	*nifan*, Ahtiago, Ceram; *nifoa*, Matabello; *nifin*, Teor
8	Water	vai	*ve*, Teto, East Timor; *wai*, Solor and others
9	White	pa-epa-e	*piuper*, Dorey
10	Ant	loi	*foin*, Ahtiago, Ceram
11	Ashes	lefu-lefu	*lavu*, Amblaw; *laftain*, Ahtiago, Ceram
12	Bad	leaga	*leak*, Mysol
13	Banana	fa-i	*fiah*, Sula Islands
		mo-i	*muk*, Teor; *mah*, Mysol
14	Belly	man*ava*	*tiava*, Batumerah
15	Bird	manu	*manu*, Camarian, Ceram
16	Blood	toto	*kokotu*, Tidore
17	Blue	uli	
18	Boat	tulula	
19	Body	tino	
20	Bone	ivi	*hoi*, Sula Islands; lu*liva*, Butumerah, Amboyna
21	Bow	aufana	*pana*, Salayer, South Celebes; *fean*, Mysol
22	Box	atola-au	
23	Butterfly	pepe	*pepeul*, Morella, Amboyna
24	Cat	gose	
		geli	
		pusi	
25	Child	tama	
26	Chopper	—	
27	Cocoanut	niu	*niula*, Gah, Ceram; *nea*, Mysol
28	Cold	ma-alili	*mariri*, Wahai, Ceram
29	Come	fotu *mai*	*mai*, Sula Islands, Lariki, Amboyna, Gah, Ceram, etc.
30	Day	ao	*heo*, Bouton, South Celebes; *aoaaoa*, Lariki, Amboyna; *lau*, Baju
31	Deer	—	
32	Dog	uli	*kafuni*, Gah, Ceram
33	Door	pupuni, puipui	
34	Ear	taliga	*telinga*, Malay, Baju, etc.
35	Egg	fua	*fuan*, (fruit) Wayapo, Bouru
36	Eye	mata	*mata*, Lariki, Amboyna, etc.
37	Face	mata	*matalalin*, Wahai, Ceram
38	Father	tama	*ama*, Wahai, Ceram
39	Feather	fulu	*fulun*, Wayapo, Bouru
40	Finger	i-lima	*limin-tagin*, Teor
41	Fish	i-a	*i-an*, Matabello, etc.
42	Flesh	a-ano	
43	Flower	fuga	*bunga*, Gani, Gilolo, etc.
44	Fly	lago	*lango*, Sanguir
45	Foot	vae	*ai*, Wahai, Ceram, etc.
46	Fowl	moa	
47	Fruit	fua	*fuan*, Wayapo, Bouru, etc.
48	Go	alu	*aou*, Wahai, Ceram
49	Gold	—	
50	Good	lelei	
51	Hair	fulu-fulu	*olofolo*, Masarati, Bouru
52	Hand	lima	*lima*, Sanguir, etc.
53	Hard	ma-a-a	*makana*, Saparua, etc.
54	Head	ulu	*ulu*, Camarian, Ceram
55	Honey	—	

	English.	Samoan.	—
56	Hot	vevela	*pela*, Mysol
57	House	fale	*bare*, Sanguir
58	Husband	tane	*burani*, Salayer, South Celebes
59	Iron	u-amea	
60	Island	nu-utoloto	
		motu	
61	Knife	polo	
		pena	
		naifi	
62	Large	latele	*lele*, Matabello
63	Leaf	'lau	*laun*, Saparua
64	Little	itiiti	*kiiti*, Wahai, Ceram
65	Louse	utu	*utu*, Matabello and others
66	Man	tagata	*tomata*, Salibabo
		tane	
67	Mat	papa	
		fala	
68	Monkey	—	
69	Moon	masina	*fasina*, Sula Islands
		mauli	
70	Mosquito	namu	*nymo*, Javanese
71	Mother	tina	*ina*, Lariki, Amboyna
72	Mouth	gutu	*nanguru*, Galela, Gilolo
73	Nail	atigi-lima, fao	
74	Night	po	*potu*, Saparua
75	Oil	u-u	*majulu*, Mysol
		suau-u	
76	Pig	pua-a	*hawhua*, Camarian, Ceram
77	Post	pou	*faolnim*, Ahtiago, Ceram
78	Prawn	—	
79	Rain	ua	*uan*, Gah, Ceram
80	Rut	imoa	
		ioli	
		isumu	
81	Red	mumu	*hamu*, Sanguir
		ulaula	*ululi*, Teor
		toto-toto	
82	Rice	—	
83	River	vaitafe	
84	Road	ala	*aya*, Sula Islands
85	Root	a-a	*ai aha*, Matabello
		pogai	
86	Saliva	anu	*udu*, Sanguir
		feanuga	
87	Salt	—	
88	Sea	tai	*tahi*, Matabello
		sami	
		vasa	
		moana	
89	Silver	—	
90	Skin	pa-u	
		iliola	*lilicolo*, Teluti, Ceram
91	Smoke	asu	*iaso*, Gani, Gilolo
92	Snake	gata	*katoan*, Sanguir
93	Soft	malulu	*mulumu*, Wahai, Ceram
94	Sour	o-ona	*ko-unim*, Ahtiago, Ceram
95	Spear	tao	
96	Star	fetu	*fatui*, Sula Islands
97	Sun	la	*lea*, Sula Islands
98	Sweet	suamalie	
99	Wax	pulu	
100	Wife	ava	*sawa*, Sanguir

English.		Samoan.	—
101	Wing	apu-au	*opani*, Bouton, South Celebes
102	Woman	fafine	*finé*, Masarati, Bouru
103	Wood	la-au	*a-au*, Cajili, Bouru
		vao-matua	
104	Yellow	sama-sama	
105	One	tasi	*isai*, Camarian, Ceram
106	Two	lua	*lua*, Wahai, Ceram
107	Three	tolu	*tolu*, Matabello
		fia	
108	Four	efa	*faä*, Amblaw
		esoani	
109	Five	elima	*lima*, Ahtiago, Ceram, and others
110	Six	ono	*ono-mo*, Bolanghitam, North Celebes
111	Seven	fitu	*fitu*, Matabello
112	Eight	valu	*walu*, Amblaw
113	Nine	iva	*siwa*, Cajili, Bouru, and others
114	Ten	sefulu	*sapulo*, Bouton, North Celebes, and others

Appendix III.

Gani, ...	Gilolo	2	3
Galela	.. .. ..	1	
Langowan	Celebes	1	
Salayer	.. .. ..	1	
Bouton	.. .. ..	3	6
Bolanghitam	.. .. ..	1	
Ahtiago	Ceram	6	
Gah	.. .. ..	5	
Wahai	.. .. ..	9	24
Camarian	.. .. ..	3	
Teluti	.. .. ..	1	
Lariki	Amboyna	5	
Batumerah	.. .. ..	1	7
Morella	.. .. ..	1	
Vaiqueno	Timor	1	
Teto	.. .. ..	1	2
Wayapo	Bouru	3	
Masarati	.. .. ..	2	7
Cajeli	.. .. ..	2	
	Amblaw	4	
	Matabello	11	
	Teor	5	
	Sasak Lombok	1	
	Solor	1	
	Dorey	1	
	Mysol	5	
	Sula Islands	7	
	Tidore	1	
	Baju	1	
	Malay	1	
	Sanguir	7	
	Saparua	3	
	Salibabo	1	
	Javanese	1	

II.—ZOOLOGY.

Art. XVI.—*On some* Coccidæ *in New Zealand.* By W. M. Maskell.

[Read before the Philosophical Institute of Canterbury, 6th June, 1878.]

Plates V., VI., VII. and VIII.

The Coccidæ—Scale or Gale insects—are a family of the order Homoptera. They are exceedingly common in all parts of the world, and I may say that in New Zealand I have scarcely come across a single plant or tree that is not in some way attacked by them. In many instances plants are found with several species of Coccidæ living on them together, and sometimes the number of insects on a leaf is so great as entirely to cover the surface, rendering the plant very unsightly.

Notwithstanding, however, the enormous number of these insects and the undoubted damage which they do, there is not much known about them. I believe I am correct in stating that in this colony nobody has yet attempted to study them: probably the very great incentives to research in other branches of natural history have diverted attention from these little pests. It is, however, curious that in older countries scarcely more knowledge has been attained regarding the Coccidæ. Books and papers respecting them are certainly not few in number. I have a list of more than a hundred authors who have written something upon the subject. But, with the exception of the insects yielding cochineal, gum-lac, and other articles of commercial value, and a few whose peculiarities of form attracted special notice, hardly any of the genera or species have, until lately, been satisfactorily described. Most of the authors referred to seem to have contented themselves either with indefinite accounts or with copying the phrases of those who preceded them.

An application to the Librarian of the British Museum, last year, made known to me a work by M. V. Signoret, a member of the Entomological Society of France, giving a monographical account of the known species of Coccidæ. After some months' delay I have succeeded in procuring this work, and I have to express my thanks to Dr. von Haast and to Professor Milne-Edwards of Paris, the former of whom wrote for, the latter of whom forwarded, a copy of M. Signoret's book to me.

The chief difficulty under which I have laboured has been that of being unable to compare my specimens of New Zealand scale-insects with those of other countries. The work just mentioned has, therefore, come most opportunely to me as a text-book.

Not professing any degree of entomological science, I may, perhaps, in my descriptions of these insects, fail sometimes in properly expressing myself. I must take my chance of this, declaring myself quite open to correction.

The Coccidæ are, as I said, a family of insects of the order Homoptera. The chief distinguishing features dividing them from all the other families are, 1st, the absence of wings or elytra in the females, and, 2nd, the absence of a mouth or rostrum in the males.

The damage done by these insects, which attach themselves to different trees, is very great. Everybody must know the scale on the apple and pear trees, which covers the trunk and branches and eventually kills the tree. Every gardener knows how destructive they are to his flowers and choice plants, whether in the open air or in green-houses. It is stated that, in France, different species of *Coccus* and *Lecanium* have destroyed whole forests of almond, orange, and olive trees; in Mauritius and in Brazil the sugar-cane, and in Ceylon the coffee-plant, has been ravaged by them. Sir Wyville Thomson, in the volumes just published of the voyage of the "Challenger," states that in the Azores the cultivation of oranges was for a time almost stopped by a small species of *Coccus*; and we all know how the oranges and lemons which come to us from Sydney are covered with innumerable insects of the same family. In Christchurch a good example of their work may be seen in the holly hedge round the Christchurch Club, where *Lecanium hesperidum* reduced the plants a few years ago to a miserable state. In Auckland, I saw a month or two ago a fine hedge of the kangaroo *Acacia* being rapidly destroyed by colonies of an insect which appears to be a new species of *Coccus*, allied to *Icerya*.

There is an immense variety in the appearance of the different species of Coccidæ, and this variety is rendered still greater by the fact that the insects themselves are by no means the same as a rule in all the stages of their existence, and by the difference between the sexes. There are, however, certain characters which belong to all the species, and with which I may fitly begin my description of those that I have observed :—

1st. In the first stage, after leaving the egg, there is no appreciable difference between the male and the female. The change in form does not take place until the insect discards its second pellicle.

2nd. The males of all species have two wings, six legs, two antennæ (generally pretty long), two proper eyes, and in some species two other eyes placed further back on the head.

3rd. The males, in their perfect state, are absolutely destitute of mouth or beak, the place of this organ being apparently taken by the two last eyes just mentionod.

4th. The females of all species are wingless.

5th. The mouth of the female, in all species, consists of a beak or rostrum, usually jointed, from which start long tubular setæ or bristles, apparently retractile, sometimes longer than the insect itself. Westwood, and after him Signoret, says that there are four of these setæ. This is certainly the case in some species, but in many instances I have been unable, though carefully watching, to see more than three, and in some specimens there would seem to be no doubt on the matter.

The above characters are constant in all the species. The differences observable will be noticed as I go on.

I may say here that, in the majority of instances, the males are extremely rare and difficult to find; in fact, for some species, such as *Mytilaspis pomorum* (the common apple scale), I believe that the male insect has never been found.

The whole family may be divided, according to Signoret, into four great groups:—

1. The Diaspidæ, of which we may take as the type the apple scale, *Mytilaspis pomorum.*

2. The Brachyscelidæ: these appear to be chiefly Australian species, and have been described by M. Schrader, in the Proceedings of the Zoologico-Botanical Society of Vienna for 1868.

3. The Lecanidæ, type *L. hesperidum*, common on our hollies.

4. The Coccidæ: our type for this will be an insect found on the Norfolk Island pine and on native trees in Riccarton Bush.

The species which I shall have to describe as being, in my opinion, new, will not, as far as I know at present, require the creation of a new group.*

I propose to take the above groups in order, and for the present shall confine myself to the first. I shall begin by giving an account of the features characteristic of the whole group; then pass on to the distinguishing features of the various genera, and lastly describe the species which I have observed.

1. DIASPIDÆ.

This group includes those scale insects which cover themselves with separate shields, composed partly of the discarded pellicles of the earlier stages, partly of a fibrous secretion more or less independent of the body of the insect.

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* *Powellia (vide post)* seems to belong to none of the above groups, but I have not yet been able to make out where to place it.

We are all familiar with the appearance of the outer shell or shield of the apple scale. The shield varies considerably in different genera: sometimes it is round, sometimes long, sometimes white, sometimes brown, but it invariably exhibits, in some part or other of its extent, when taken from the adult female insect, the two pellicles which she has discharged in her earlier transformations. In my plate V., fig. 1*a*, is shown part of the shield of the apple scale, mounted to show the pellicles. In the shield of the male insect, in certain species, only one pellicle appears, the insect undergoing only one transformation before the pupa stage.

The female insect, having arrived at her full growth, fills her shield with eggs. A figure of its appearance is given in plate V., fig. 1*b*, for the apple scale.

The young insect shows no sexual differences. It is oval in shape (plate V., fig. 1*c*), with six legs, two antennæ, and two eyes.

The female, discarding her first skin, throws off also at the same time all external organs except the mouth or rostrum. In the first pellicle attached to her shield the remains of the antennæ may almost always be seen. The legs are not to be found, and I cannot say what becomes of them. The insect, thus debarrassed of her limbs and eyes, becomes only an inert mass. She remains thus for some time, merely feeding and growing, still retaining an oval shape, as shown by the second pellicles in the shield. Throwing off this pellicle, she appears in her adult stage, a description of which must be left till I come to each species, as they differ considerably.

What I have just said as to the discarding of the limbs is, like every rule, subject to some exception. In one or two species, chiefly of the genus *Mytilaspis*, a pair of minute protuberances, which M. Signoret states are rudimentary antennæ, are visible on the head.

The adult female, whatever her shape, oval or round, is much corrugated, in fact made up of rolls of fat, with the exception of the head—which is usually smooth, and of the abdomen—which is peculiarly shaped and marked. The colour of the insect as a whole varies—being sometimes whitish, sometimes pale yellow, sometimes red.

In all cases that I have observed the abdominal region is of a bright yellow colour, and it is from the markings of this portion of the body that the *specific* differences of the genera of Diaspidæ are taken. My plate V., fig. 1*d*, gives the appearance of the abdomen of *Mytilaspis pomorum*, the apple scale, which I have taken as the type of the group. It will be seen that the corrugations of the body end a short distance from the posterior extremity, which has a curved outline, broken by numerous small lobes, intermixed with scaly hairs. The anal opening is at what might be termed

the focus of the curve (this does not hold good for all genera), and it is surrounded by groups of minute circular marks, arranged like bunches of grapes, whilst other marks are scattered singly over the abdominal region. These marks, which are in reality the open ends of tubes, are supposed to be a kind of spinnerets from which the insect builds round itself the shield of which I spoke just now. Some of the chief characters upon which the specific differences of Diaspidæ are founded, are the presence or absence of these spinnerets, the number of the groups, their continuity or separation, and the number of openings in each group. There are other features, such as difference of outline in the body, difference of shape of shield, difference of form of the male, difference of length in the thoracic band of the male. But these are often more properly generic than specific differences; moreover, the excessive rarity of the male insects renders it very difficult to arrive at certainty from them; whereas the abdominal markings of the females are in general so distinctly clear that they offer an excellent means of distinguishing between individuals.

The mouth is, as I said above, absent entirely in the male insect in its perfect state. The mouth of the female consists of a rostrum, or beak, on the underside of the head, some little way from its anterior edge. It appears in the Diaspidæ to have no joints, and from its interior start three (or in some cases four) very long, thin tubular bristles, which, I suppose, the insect inserts into the stomata or minute orifices of the plant on which it lives, for the purpose of withdrawing thence its food. My plate V., figs. 1*e* and *f*, show this rostrum (which is, with modifications, common to all Coccidæ), as it appears on the insect, and as it shows after mounting for the microscope.

So much for the general features of the female. The male differs a good deal in shape in various species, but, as far as it is known, has always two wings, six legs terminated by a single claw, antennæ usually of ten joints, and, at the posterior end of the abdomen a long double spike, sometimes nearly equal in length to the whole body. The insect undergoes three transformations. From the egg it emerges as an oval insect similar in all respects to the female; in some species it surrounds itself with a shield like that of the female, in others the shield is much longer and narrower. After a time it discards its first pellicle and remains in the shield, gradually changing into the pupa stage. During this process, according to M. Signoret, the successive formation of the eyes, wings, antennæ, and abdominal spike may be observed. I have specimens of pupæ of *Aspidiotus epidendri*, in which this formation is apparent. The first pellicle is the only one which remains attached to the shield, as the insect emerges from the pupa stage, winged and perfect; consequently, in some species it is possible to distinguish between the shields of the two sexes simply from the presence in one of two pellicles, in the other of only one.

Having thus briefly enumerated some of the characters which are common to all the Diaspidæ, I proceed to particulars.

The group is divisible into several genera, but I need now only mention those of which I have obtained specimens in this country. Considering the immense number of plants, imported or native, whether in greenhouses, gardens, or the bush, which are attacked by scale insects, and the multitudinous variations of form and markings which distinguish the individuals, it is likely that future research will discover, if not new families and genera, at any rate many new species.

The genera known to me at present are the following :—

1. Mytilaspis. This includes the apple scale and many others. The shield, or puparium, is elongated ; the two discarded pellicles are seen at the smaller end.

2. Aspidiotus. Shield of the female round, or nearly so ; that of the male somewhat oval ; discarded pellicles in the centre.

3. Diaspis. Shield of the female round, as in the last genus ; the discarded pellicles usually near the side ; shield af the male elongated.

Subsection I.—Mytilaspis, *Linn.*

The females in many species of this genus, as a rule, resemble each other in form. The number and disposition of the groups of spinnerets offer a means of distinguishing the species. The males, in most cases, are unknown.

1. *Mytilaspis pomorum*, the apple scale.

Plate V., figs. 2*a, b, c, d.*

This species is not indigenous. The shield, which may be seen covering the trunks and branches of our apple, pear, and other trees, is elongated, mussel-shaped, brown or grey (I have seen some white). It is open underneath, adhering to the tree with its edges ; it has considerable consistency ; length averaging $\frac{1}{10}$ inch, breadth nearly $\frac{1}{30}$ inch. The discarded pellicles are at its smaller end, and, when mounted in balsam, the rest of the shield is seen to be composed of transverse interlacing curved fibres.

In the spring, a close inspection of a branch of apple tree will show a number of extremely minute yellowish specks intermingled with the adult puparia. These specks are the young of the insect, hatched and beginning to travel on their own account. Plate V., fig. 1*c*, shows the form at this stage. It is oval, flattish, yellow-coloured, with two antennæ, each with six joints (of which the last is the longest) ; the antennæ have longish hairs on each joint. The head is smooth, rather darker in colour than the body, with four hairs on its anterior edge. The body is corrugated, each corrugation having a spine. The anal extremity is yellow, with several hairs, of which two are of some length. The legs have short femora, tibiæ rather

longer and very thick, tarsi somewhat longer and thin, and a single claw at the tip. Just above the claw spring two long hairs each ending in a knob.

After fixing upon a suitable resting-place the young insect remains in the same state for some time, and then undergoes its first transformation. The result of this is seen in the puparium, where the oval pellicle overlying what is evidently the pellicle of the young one shows that it becomes merely an oval inert mass. The antennæ and legs disappear, the skin of the former remaining attached to the first pellicle. The mouth only survives the change. In this second stage the insect begins to spin its shell, or puparium, and after another interval undergoes another transformation appearing at length in the shape shown in plate V., fig. 2*b*, or as the perfect female.

The body is here seen to have lost its former regularly oval shape and to have become longer. The cephalic end and about half the rest are smooth, the remainder much corrugated. There are no legs, or antennæ proper, but in some specimens may be seen two extremely minute protuberances on the head, each with a few attached hairs, which are said to be rudimentary antennæ. Some of the corrugations near the abdomen have three or four spines. The mouth, or rostrum, which is of the same general character as in all Coccidæ, exhibits three very long setæ.

The abdominal region, as in all Diaspidæ, is bright yellow. Plate V., fig. 2*c*, shows its outline, which is a pretty regular curve broken by a number of small triangular and foliated lobes. Two of these lobes, in the middle, are the largest, and have on each side of them one smaller lobe. Between the lobes are several strong spines. The anal orifice is situated at what might be called the focus of the curve of the abdomen; it is oval and hairless.

Forming an arch around the anus are five groups or bunches of minute circular openings, which are the spinnerets used in building up the puparium. In the uppermost group are 17 openings, in each of the two upper side groups 17, and in each of the two lower groups 14. Plate V., fig. 2*d* shows the appearance of these spinnerets, magnified 700 diameters. A few single spinnerets are scattered about the abdominal region, and near the edge of the abdomen is a row of egg-shaped openings, larger than the others, the narrow ends of the eggs pointing outwards; these are arranged in pairs.

I am inclined to think that the whole abdomen is covered with extremely minute fine hairs, for it usually presents a velvety appearance, with very fine parallel striæ.

When in its perfect stage the female insect occupies nearly the whole puparium. Later on, however, she begins laying her eggs, with which she gradually fills the shield, shrivelling up herself into the narrow end of it.

The eggs, according to my observations, are usually from thirty to fifty in number, oval in shape, of a white or opaline colour, changing to yellow as spring comes on.

The males of this species have yet to be discovered.

I have often found amongst the eggs of *Mytilaspis pomorum* a minute white *Acarus*. It is to be hoped that it feeds largely on the eggs.

Several cures for this pest of the apple tree have, I believe, been tried. Mr. A. Carrick, of Park Terrace, showed me last year a tree of his which he had painted over with a mixture of kerosene and linseed oil. Inspection of the puparia showed that the fluid had thoroughly penetrated them and surrounded the eggs ; and I understand that the cure has been complete.

Mytilaspis pomorum attacks in this country the pear and plum trees as well as the apple. Indeed, I have found specimens identical in almost every respect on the following trees :—plum, peach, apricot, pear, lilac, cotoneaster, thorn, sycamore, ash, and many others. That these are all the same or different species, I do not like to affirm. Yet in the numbers of their spinnerets they differ. M. Signoret states that in Europe *Mytilaspis pomorum* is found only accidentally on the pear tree, sometimes on the plum ; and he names scarcely any other trees. Here all those which I mentioned appear to be indiscrimately attacked by them. The scale on the ash is perhaps a little smaller. I give, however, as an indication for comparison the spinnerets of insects on a few of these trees :—

—	Uppermost Groups.	Upper side Groups.	Lower side Groups.
Apple	17	17	14
Plum	20	17	17
Lilac	17	19	16
Ash..	10	12	9
Cotoneaster	7	15	10

2. *Mytilaspis pyriformis*, sp. nov.

Plate V., fig. 3.

The puparium is broadly pearshaped, the discarded tests occupying the smaller end ; the tests are of a pretty regular oval shape ; the pellicle of the second stage reaches to about the middle of the puparium. Colour of shield light brown ; texture thinner than in *Mytilaspis pomorum*, and form flatter ; length about $\frac{1}{12}$ inch ; greatest breadth about $\frac{1}{20}$ inch. Plate V., fig. 3*a*, shows the appearance of the puparium.

This species in the shape of its shield and a few other particulars resembles *Mytilaspis buxi* of Bouché ; but there are differences which authorise me, I believe, in considering it as new.

The adult female is deeply corrugated except (as in every *Mytilaspis*) on the cephalic portion. The corrugations bear a few strong spiny hairs. The abdominal pygidium shows an almost continuous arch of spinnerets over the anal orifice. In *Mytilaspis buxi* the groups are distinct. The spinnerets of *Mytilaspis pyriformis* run in a double ring round the anus, with here and there an outlying opening. Altogether there may be from 60 to 70 openings in the arch. There are many single spinnerets scattered about, a large number of them more or less oblong; and they may be traced up the sides of the body as far as the corrugations extend. Plate V., figs. 3*b* and *c*, show the appearance of the female and the arrangement of the spinnerets.

The abdomen, including all that is tinted yellow, does not show a continuously curved outline. On each side, next to the last corrugation of the body, is a large triangular lobe, the apex furnished with scaly, triangular, serrated hairs. The rest of the abdomen shows a curve broken by small lobes, of which the two middle ones are the largest, the next two on each side smaller, and the rest inconspicuous. Between the lobes are scaly hairs, and near the edge runs a row of large oblong openings.

I have a specimen of a scale from *Dysoxylum spectabile*, which seems to resemble much more nearly *Mytilaspis buxi:* and this is not unlikely, as the specimen came from a greenhouse.

3. *Mytilaspis cordylinidis*, sp. nov.

Plate V., fig. 4.

This scale, which appears to be also new, I have found on a great number of New Zealand plants, such as *Cordyline*, *Asplenium*, *Phormium*, *Gahnia*, *Drimys*, *Astelia*, and many others. I have also seen it on *Eucalyptus globulus*, but only in the vicinity of New Zealand trees. It is perhaps more abundant on the cabbage tree than on others; hence I have named it as above.

The puparium is very long and narrow, generally straight, sometimes curved, semi-cylindrical. Length about $\frac{1}{8}$ inch; breadth $\frac{1}{30}$ inch. Colour pure white, except at the end where the discarded tests are; these are bright yellow. The tests are oval; the second more elongated than the first, and the two together generally occupy rather more than a quarter of the length of the puparium. The eggs are small, oval, and of a bright yellow colour.

The adult female is pale golden, about three times as long as broad; the cephalic end a little flattened anteriorly, and above the rostrum are often seen the two minute hairy protuberances called rudimentary antennæ. The body is somewhat corrugated, but less so than in *M. pomorum:* the corrugations show a very few fine hairs.

The abdomen exhibits a curve almost continuous and regular, broken only by very small lobes except in the middle, where there is a deepish depression with a large lobe on each side. Between the lobes are scaly serrated hairs, some of which are pretty long.

There are five groups of spinnerets of which the middle has 7 to 8 openings, the two upper-side ones 14 to 20, the two lower 20 to 25.

There are a great number of single spinnerets, a few oval or circular, the majority oblong. They are placed in curved lines arching round the pygidium, each arch lining the groove of a corrugation, and are visible on the sides of the body nearly to a level with the rostrum.

The male insect is very minute and difficult to find. I succeeded in procuring one specimen, though not in good order. I could observe that the antennæ were short and the tibiæ excessively large.

Plate V., fig. 4*a*, is the puparium; fig. 4*b*, the adult female; fig. 4*c*, the pygidium.

4. *Mytilaspis drimydis*, sp. nov.

Plate V., fig. 5.

I have found this species on a great many native plants, but more often perhaps on *Drimys colorata*, whence I give it its name.

The puparium is straight, long and narrow, but not so much so as in *M. cordylinidis*. Average length $\frac{1}{12}$ inch; breadth $\frac{1}{30}$ inch; colour generally a dirty white, sometimes brown, yellow at the end with the discarded pellicles, which are oval, narrowing somewhat at the tip.

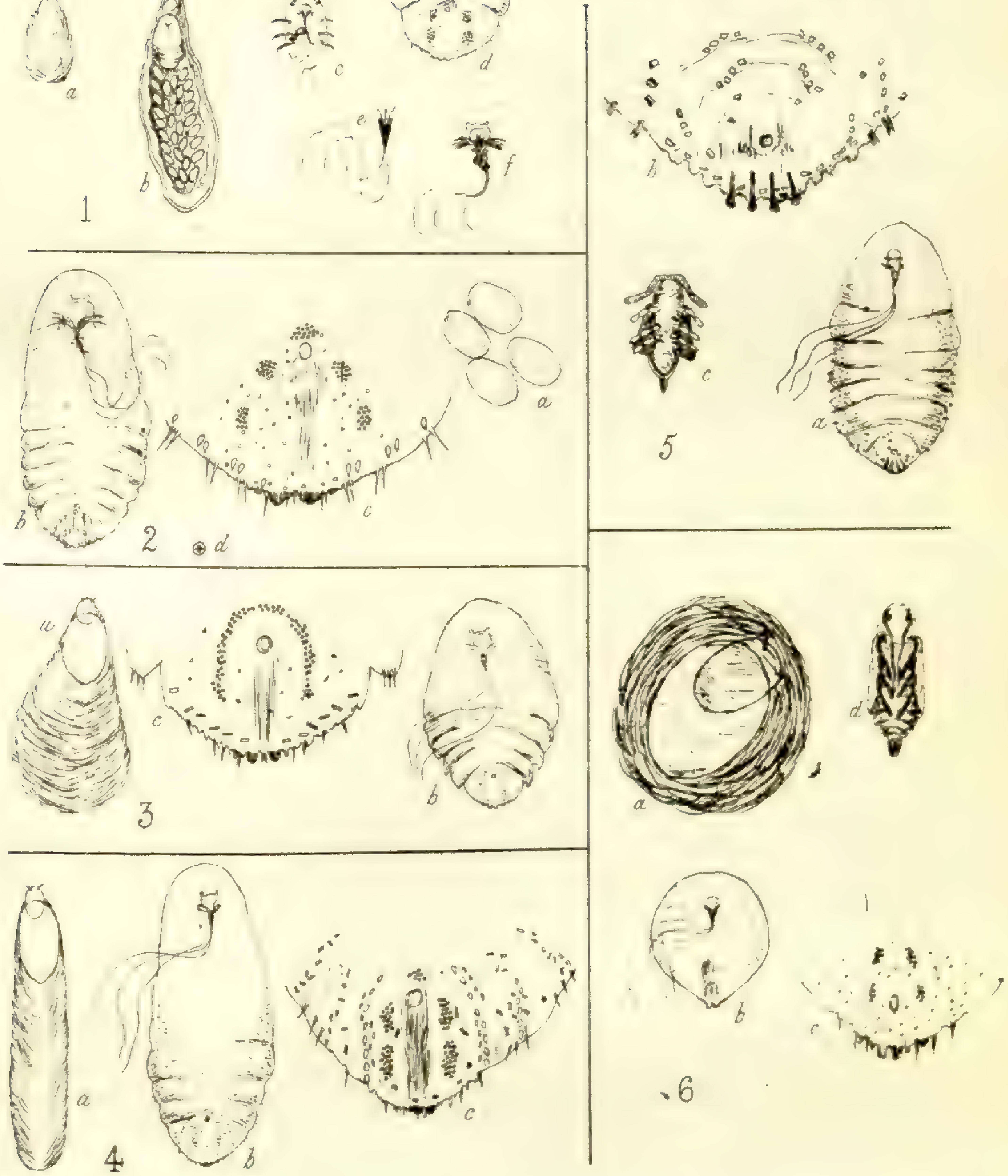
The adult female is of a dull red colour, about twice as long as broad; the widest part is about two-thirds of the length from the head. It is less corrugated than *M. pomorum*; the head and thoracic portion of the body are smooth and round, the anterior edge not so much flattened as in *M. cordylinidis*. The remainder of the body, on the corrugations, has a row of short, thick, tubular bristles extending down the edge as far as the commencement of the abdominal pygidium; these are cylindrical, some with a circular top, some forked, some appearing like bundles of parallel fibres. It is probable that they are spinnerets protruding further than is usual in other species.

There are no groups of spinnerets on the abdomen, but a number of single ones, mostly oblong, scattered about.

The abdomen ends in a number of very small lobes of which four are conspicuous in the centre. Between the lobes fine hairs.

On the cephalic region are a few scattered spines and the two rudimentary antennæ.

I have no adult male, but pupæ showing long antennæ, a very long body, short wings and the usual abdominal spike peculiar to the Diaspidæ.



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Males of this species are not so rare as in some others, and I hope before long to have a perfect specimen.*

Subsection 2.—Aspidiotus, Bouché.

This genus is characterised by a round, or nearly round, puparium; the discarded pellicles are in the middle, and usually their major axes are inclined to each other. Several species are known in Europe.

1. *Aspidiotus epidendri*, Bouché.

This is a well-known species. In Mr. Duncan's hothouses it may be found in abundance upon the *Seaforthia* palm, upon *Lælia anceps* and other orchids, and on several other plants.

The puparium is round, flat, of a dirty white colour, sometimes (as on the wattle) brownish; the pellicles in the centre are yellow; the fibres run in interlacing circles.

The eggs are yellow; the young insect is oval, somewhat broader than in *Mytilaspis pomorum*, and has at the posterior extremity two protruding lobes with a pair of very minute lobes between them.

As a rule, the insects are found in considerable numbers, in colonies, the puparia of the females intermingled with the young and with the cocoons of the males.

The pellicle of the second stage is oval, tapering to the posterior extremity.

The adult female is almost round, or rather in the shape of a peg-top. Plate V., figs. 6*a* and *b*, show the insect and its puparium. The curve of the cephalic portion is circular and smooth; no hairs are visible, but the two rudimentary antennæ can be seen. The abdominal region is yellow, ending in lobes of which the two middle ones are the largest; between the lobes are very fine hairs. The pygidium has four groups of spinnerets; the two upper groups have from eight to ten openings, the two lower from six to eight. Many single spinnerets.

The puparium of the male is elongated, cylindrical. At one end is seen the pellicle of the first stage. The male escapes from this cocoon, when perfect, backwards. This mode of egress is, as I understand, not uncommon amongst the Coccidæ.

In the pupa stage the male (plate V., fig. 6*d*) exhibits the wings, legs and abdominal spike coiled up to fit the cocoon.

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* Since writing this paper I have obtained a specimen of the adult male. The wings are about equal in length to the body. The antennæ have ten joints, of which the two first are very short and thick, the rest very long and thin, covered with hairs and equal to each other with the exception of the last which is spindle-shaped. These antennæ resemble those of the male of *Diaspis gigas* described below. The thoracic band is inconspicuous. The legs have a rather large tarsus and are hairy.

In its perfect state the male has a roundish head with two globular eyes on its anterior portion, and further back, in the place where the rostrum should be, two other eyes (?) filled with a mass of pigment. The antennæ are long, hairy, ten-jointed. The wings are a little longer than the body. The thorax is somewhat broad, with a band crossing it near the middle; this band (seen I believe in all species of Diaspidæ) does not in this species reach across the whole thorax. The abdomen, smaller than the thorax, is oval, and ends in a tubular sheath from which start the two long spikes characteristic of the Diaspidæ. The legs exhibit a few hairs; the femora are thick; the tibiæ not very long, narrow; the tarsi end in the usual single claw.

2. *Aspidiotus budlæi*, Signoret.

On the silver wattle, in Nelson, last year, I found specimens which I believe to belong to this species. I have had one or two from a tree of the same kind in Christchurch. My specimens are all females.

The difference between this and the last species is, for the female, in the number of the spinnerets. These are in four groups, the two upper ones having only five or six openings, the two lower only three or four.

It is possible that these specimens may be *Aspidiotus aloes*. It requires an examination of the male to distinguish clearly.

3. *Aspidiotus atherospermæ*, sp. nov.

I take this to be a new species; I have it from an indigenous tree, *Atherosperma novæ-zealandiæ*. The puparium resembles that of *Aspidiotus epidendri*, but is somewhat darker in colour. The adult female is much more corrugated, and the corrugations overlap the abdominal region. The pygidium has four groups of spinnerets; the upper pair have 15 openings, the lower 9 or 10. The abdomen ends in several lobes, of which the four middle ones are the largest. The rest of the lobes are sharply pointed. Between the lobes are scaly serrated hairs.

Plate VI., figs. 7*a* and *b*, shows the adult female and the abdomen.

4. *Aspidiotus dysoxyli*, sp. nov.

Plate VI., fig. 7.

The puparium is brown, somewhat convex, the underside white. The female in the middle is bright yellow, corrugated, the corrugations overlapping the abdominal region which is comparatively small. There are four groups of spinnerets—the upper pair with ten openings, the lower with nine, many scattered oval and oblong spinnerets. The abdomen ends in six lobes, of which only the two median are conspicuous; between the lobes fine, serrated hairs. The abdomen is very velvety.

In the second stage, shown in plate VI., fig. 7*c*, the body is more oval and less corrugated, and the rostral setæ are exceedingly long.

With the exception of the abdominal lobes and the numbers of spinnerets in the groups, the adult female resembles *Aspidiotus atherospermæ*.

5. *Aspidiotus aurantii*, sp. nov. (?)

Plate VI., fig. 8.

This is not an indigenous species, being found in immense numbers upon the oranges and lemons in our shops, imported from Sydney. As, however, it occurs on orange trees growing at Governor's Bay, I introduce it here.

M. Signoret describes, under the name of *Parlatoria zizyphi*, or *aurantii*, an insect infesting orange trees in Europe. Its form, as given in his plate V., fig. 9, bears certainly great general resemblance to the insect I am describing, but it differs altogether in the shape and colour of the puparium, and the abdominal lobes are also different.

The puparium of *Aspidiotus aurantii* is round, yellowish, flat. The insect, in the centre, is curiously shaped. It has a generally spherical outline, but looks as if, from rich feeding, rolls of fat were produced, making the corrugations of the body very largely overlap the abdomen. It is yellow, the abdomen being the deepest coloured. The curve of the body and head is regular and smooth; the rudimentary antennæ are absent; the abdominal region, very small in comparison with the rest, ends in six lobes of which the two middle ones are the largest. There are no groups of spinnerets.

The young insect (second stage) is somewhat different, being of a nearly regular oval shape, without the rolls of fat.

The male is very small, brown in colour; the antennæ have ten joints. The two first joints are very small, round and smooth; the third, fourth, fifth and sixth equal in length, the seventh, eighth and ninth half as long, the tenth somewhat shorter still and pointed. All the last eight joints show numerous hairs. The thorax is short and thick, the thoracic band occupying more than one-half the width; the abdomen short, the double spike of some length. The wings are oval, about as long as the body. The legs are hairy, femora thick, tibiæ longer, thicker at the end next the tarsus than at the other end; tarsi broad at the top, tapering gradually down to the usual single claw. The hairs on the femora are much fewer than those on the tibiæ and tarsi.

This insect does not correspond in any particular with the species described by M. Signoret, except in the general outline of the adult female, resembling *Parlatoria*. Nevertheless, as it is manifestly not a species indigenous to New Zealand and must be known to entomologists, I give it the name of *Aspidiotus aurantii* only in default of better information than I have at present. M. Schrader, in the work above cited, mentions an insect

attacking orange trees in Sydney, which, he says, "appears to be an *Aspidiotus*." I take it that this is my *Aspidiotus aurantii*; but it would seem from his expression that hitherto no detailed description has been given of it.

[Note.—*Aspidiotus limonii*, Signoret, cannot be this species.]

Aspidiotus camelliæ, Boisduval, attacks camellias in our greenhouses. It somewhat resembles *Aspidiotus nerii*, but there are no groups of spinnerets.

Subsection 3.—*Diaspis*, Costa.

In this genus, as in the last, the puparium of the female is round and flat, but the discarded pellicles are usually at the side instead of in the centre. The female is generally rather more elongated than in *Aspidiotus*. The puparium of the male is long and narrow; the perfect insect does not differ from *Aspidiotus*, except that the space between the first and second pair of legs appears disproportionately long.

1. *Diaspis boisduvalii*, Signoret.

Plate VI., fig. 9.

This is an European species. I have found it in abundance upon orchids in Mr. Duncan's hot-houses. The female is somewhat pear-shaped, the cephalic region smooth, with a protruding lobe at each side on a level with the rostrum, distinguishing it from all the other species. There is sometimes a cottony fluff on the body. The widest portion is a little below the lateral protuberances; from thence it tapers gradually to the posterior extremity, where the abdomen ends in two lobes with a depression between them. The abdominal curve is broken by small serrations with a few spiny hairs amongst them. The pygidium has five groups of spinnerets; the uppermost group has from five to eight openings, the two upper side ones twenty to twenty-five, the two lower somewhat less. There are a few scattered single spinnerets, mostly oblong.

The male is very small; its cocoon is white, cylindrical, with the discarded pellicle (similar to that of the female) at one end. As in *Aspidiotus epidendri*, the perfect insect escapes from its cocoon backwards (Plate VI., fig. 9*b*. The head is transverse, grooved in front, with four eyes, of which the two occupying the position of the rostrum are full of pigment. The antennæ spring from the anterior region; they are very long, having ten joints, of which the two first are short and thick, without hairs, the remainder twice as long but narrower, and covered with fine hairs. The last joint (which possibly may consist of two or three soldered together) is spindle-shaped.

The thorax is long; the thoracic band conspicuous, but occupying only about half the width of the body. The wings, which appear to have only a

single nervure, are oval, and extend far beyond the extremity of the abdomen. The abdominal spike, which has a tubular sheath of larger size and length than in *Aspidiotus*, is double and long, but does not reach the tip of the wings.

The legs are hairy; femora and tibiæ about the same length, but the former thicker than the latter; tarsi thick and spindle-shaped, ending in the usual single claw. The great distance between the first and second pair of legs gives the insect a peculiar appearance.

2. *Diaspis rosæ*, Sandberg.

Plate VI., fig. 9*c*.

This also is European. It occurs here on rose trees at Governor's Bay, in Mr. Potts's garden. The puparium is flat and white, and the discarded pellicles on one side. The adult female is of a deep red colour, elongated in form, distinguishable from all other species by the size of the cephalic region and the deep corrugations of the body. Its appearance is more striking than that of any other species of the Diaspidæ, and the contrast of the blood-red head and thorax with the bright yellow abdominal region is curious.

The cephalic region, mushroom-shaped, is quite smooth. There is no appearance of rudimentary antennæ. The body has four large corrugations, nearly equal in size, and on the last two are a few spiny hairs. The abdomen, broken by serrations, ends in two lobes with a depression between them. The pygidium has five groups of spinnerets, but the side groups are almost continuous. The upper group has about 20 openings, the side ones 50 or 60; there are no single spinnerets but on each side 3 or 4 rows of large oval openings forming arches.

The young insect is brown, oval, with the head a little flattened anteriorly; the legs and antennæ and abdominal hairs as in other species.

The cocoon of the male is white, cylindrical. I have not yet a specimen of the perfect insect.

3. *Diaspis gigas*, sp. nov.

Plate VI., fig. 10.

I found this species on *Atherosperma novæ-zealandiæ*, a North Island tree, of which Mr. Armstrong gave me a branch some months ago. I believe it best, as a rule, to use the name of the tree on which a scale-insect lives as its specific name, but as I have already used this particular name in the case of an *Aspidiotus*, I prefer, in order to avoid confusion, to call the present species by a descriptive title. I have lately found it in abundance on a species of *Astelia*, in Riccarton Bush. It is the largest of the Diaspidæ which has yet come under my notice; the puparium of the female is sometimes more than $\frac{1}{8}$ inch long and $\frac{1}{16}$ inch wide; the female reaches $\frac{1}{12}$ inch in length.

The puparium is yellowish-brown or dirty white, flat, roughly pear-shaped, thin in texture. The discarded pellicle of the first stage occupies the broad end of the pear; that of the second nearly fills the puparium. This second pellicle is different in shape from those of other species. Instead of being oval in shape with a regularly curved outline, it is nearly identical with the form of the adult female. Its cephalic and thoracic portions are very large, oval, and smooth; at the point corresponding to the metathorax are two prominent lobes, triangular, with rounded angles, the apex of each turned slightly outwards. The outline then descends with three or four other smaller lobes to the extremity of the abdomen. Plate VI., fig. 10*b*, shows the appearance of this pellicle.

The adult female would appear to be, in its earlier state, as large as the second pellicle, that is, filling the puparium or nearly so. In the specimens which I obtained the female had begun in every instance to lay her eggs, and was gradually shrivelling up. Her appearance is shown in plate VI., fig. 10*a*. It will be seen that the lobes visible in the pellicle are here absent, but I am not sure whether this is not the effect of the shrivelling of the body.

The cephalic region is still proportionately very large. The abdomen is conical, the sides broken to within a short distance of the extremity by sharp serrations, between which are triangular scaly hairs. There are no groups of spinnerets, and only a few scattered single ones.

The puparium of the male is long, narrow, whitish, and with the appearance of a semi-cylinder lying upon a plane base. The perfect insect, in general appearance, resembles the male of *Diaspis boisduvalii;* but the abdomen is not nearly so long, and the tubular sheath of the abdominal spike is much smaller, being nearly globular. The antennæ are much the same as in *D. boisduvalii.* The thoracic band occupies about half the width.

This species appears to be very subject to fungoid growth. In dealing with the succeeding families of Lecanidæ and Coccidæ, we shall find that very many of their species are subject to fungus; but in the Diaspidæ, so far as I have been able to observe, this is not the case. *Diaspis gigas*, however, on the branch of *Atherosperma*, which I received, was in several instances entirely overgrown by a fungus which appeared to me to belong to the Physomycetous Order and family Antennariei. In one instance this growth, which was clearly attached to the puparium, extended nearly an inch in every direction round it.

4. *Diaspis* —— (?)

Plate VI., fig. 10*e*.

On the same tree, *Atherosperma*, I found a *Diaspis* which may perhaps be an abnormal form of the last species, perhaps distinct. The puparium

was oval; the adult female, somewhat resembling *Mytilaspis pomorum*, was dark yellow in colour, irregular in shape, having three prominent lobes on each side. The male puparium was oval; the enclosed pupa was not to be clearly made out, but seemed to resemble *Diaspis gigas*.

The above include all the species of Diaspidæ which I have as yet observed. There are doubtless many more in the country, and I hope at some future time to be able to procure new specimens. Meanwhile I shall go on to the next family of scale insects, the Lecanidæ.

Since writing the above I have found three other Diaspidæ, which may be new species, but which I have not had time to thoroughly examine.

The first, a *Mytilaspis*, is found on a small *Leucopogon* growing on dry soil in the hills. It is yellowish, with a puparium somewhat pear-shaped, quite white, and rather tough. It is very minute, averaging only about $\frac{1}{20}$ inch in length. The puparium of the male seems to be narrower, if the specimens I have looked at are the cocoons of males. The abdominal region of the female has a pygidium with eight groups of spinnerets; the lower groups have from twenty to thirty openings in each, the upper only from four to six. There are a great number of cylindrical protruding tubes. The abdomen ends with six spines. The lobes are inconspicuous, with a medial depression.

Another *Mytilaspis*, found on a very small *Mesembryanthemum* growing moss-like in our river-beds, appears to differ from the last only in its colour, which is dull red. I am not sure how far mere colour may be taken as constituting a specific difference.

The third insect, growing on the Wild Irishman *(Discaria toumatou)*, seems to me a species of *Diaspis;* but the only specimens I found were a number of discarded pellicles of the female mixed up in a mass of white cottony fibre as in *Diaspis rosæ*.

I hope shortly to be able to identify all these insects.

I HAVE now to pass from the first group of Scale Insects to the second group, the Lecanidæ. In investigating this group it will be necessary first of all to divide it into several classes, because otherwise it will be impossible to avoid confusion. The number of genera and species of the Lecanidæ is so great, the plants infested by them are so various, and their specific differences so slight in many instances, that it is easy, I should say, to fall into errors concerning them. I have, however, no intention of dwelling at length upon those species which, although attacking plants in this country in gardens or greenhouses, are European, and described by other observers. Of these, as far as my experience goes, we have in New Zealand several; but, with one exception, which I take as the type of the group, I shall pass lightly over them and go on to the genera and species which I believe to be new and indigenous.

The Lecanidæ affect the most varied forms and habits. Some are flat, some are globular; some are naked, some covered with a test which may be cottony, or glassy, or waxy; some are viviparous, some form cocoons or nests for their eggs. But there are two characters which very clearly distinguish them all from the Diaspidæ. These are the presence of a mentum or under lip, and an abdomen cleft at its posterior extremity, with two triangular lobes above the cleft.

In the Diaspidæ the rostral setæ are clear of the body from the moment they leave the tip of the rostrum. In the Lecanidæ the setæ pass some little way down the body, and then, returning towards the rostrum, pass through a second tube, or mentum, as shown in plate VI., fig. 11*a*. This mentum is also visible in the next group, the Coccidæ proper; but it is there articulate, whereas in the Lecanidæ it has but one segment.

The rostral setæ appear to be generally three, but in some instances I can observe that one of them is double.

The abdominal cleft and its lobes are shown in plate VI., fig. 11*b*. There are of course specific differences in the size and shape of these lobes, in the hairs on the abdomen, and in the spines surrounding the anal ring.

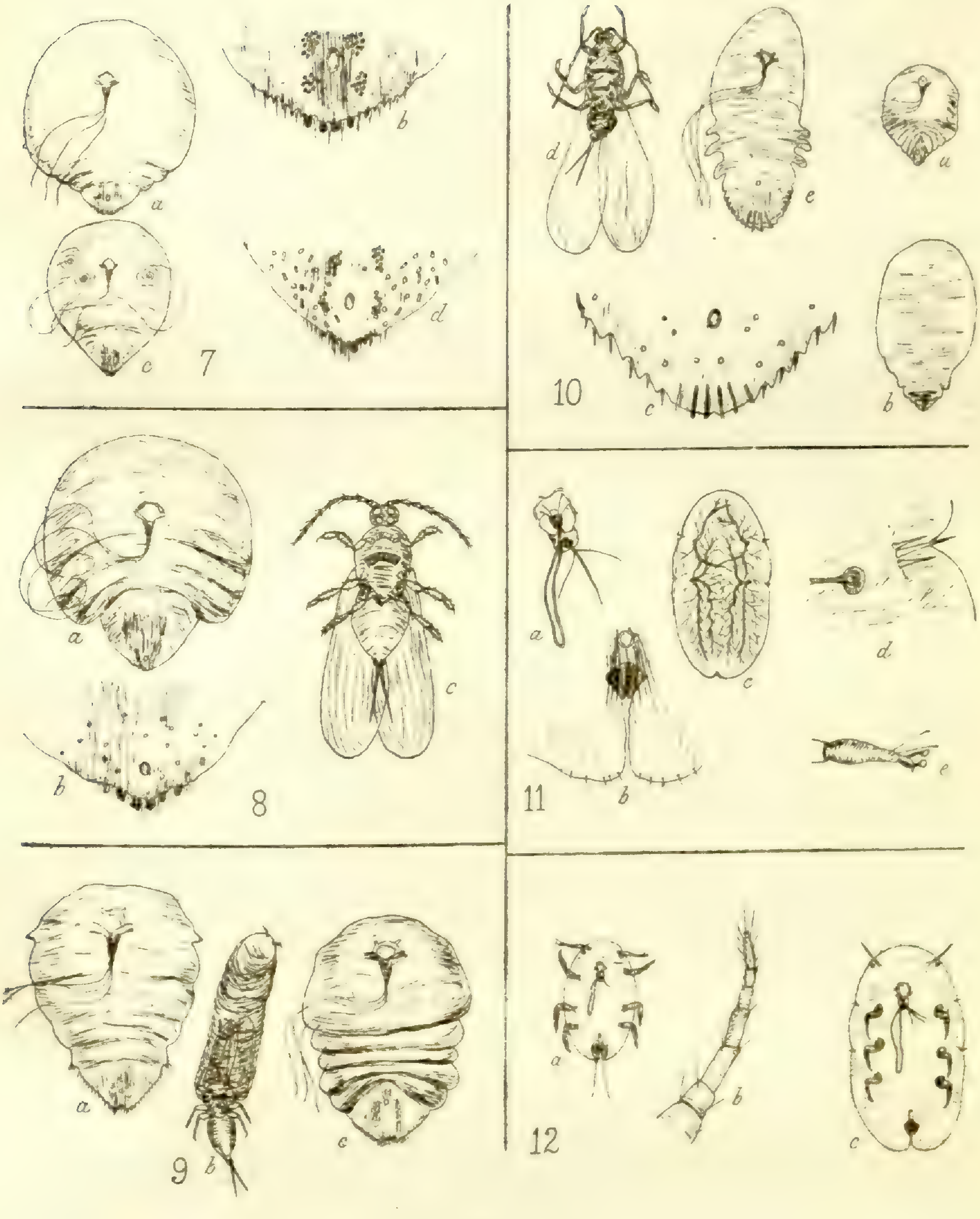
In plate VI., fig. 11*c*, I give a representation of the respiratory system of a *Lecanium*, the arrangement of which does not greatly differ in the species which I have observed. It will be seen that there are four stigmata, from each of which start large tracheæ covering the body with their ramifications. Fig. 11*d* gives a magnified figure of a stigma, mounted in balsam, with the stigmatic spines.

The antennæ in the young insect have usually six or seven joints; in the adult female seven or eight. The feet end in a single claw; just above the claw spring four hairs, of which the two uppermost are long, ending in a small knob, the lower pair generally shorter and broader, swelling out into a club at the end. See plate VI., fig. 11*e*.

The males of most of the Lecanidæ are, I believe, unknown. I have been fortunate enough to procure specimens of males of one indigenous species.

The two distinguishing characters just mentioned, the uni-articulate mentum and the bi-lobed abdomen, are best observed in the young insect. The former, indeed, is often not to be made out in the adult, but the latter is generally conspicuous enough to prevent mistaking one of the Lecanidæ for an insect belonging to another group.

All the Lecanidæ are very much infested by a fungus, apparently of the order Coniomycetes. No doubt most people have observed that plants attacked by scale, such as for instance the holly, or the ivy, have also their leaves much blackened. The blackening is due to the fungus just mentioned.



COCCIDÆ

My subsections of this group, after having said so much of its general characteristics, are as follows :—

1. *Lecanieæ*, for the species having the body of the female naked, often viviparous.

2. *Pulvinarieæ*, for the species having the body naked, but formimg cottony nests for the eggs.

3. *Lecanio-diaspidæ*, for the species having the body covered with a test; sometimes viviparous.

Of course, I am here only paying attention to such classes as contain genera known to me in New Zəaland. There are many other divisions, but they do not come within my scope.

Subsection I.—LECANIEÆ.

All the species which I have observed in this class are European, and I might therefore, according to my intention expressed just now, pass them over without entering into details. But there is one species which has become so widely spread and so noxious in this country, and which is moreover so excellent a type of the whole group, that I am constrained to dwell more particularly upon it. This species, which infests in our green-houses a vast number of plants, and in our gardens the holly, ivy, ilex, bay, Portugal laurel, orange and other trees, is, I suppose, tolerably well known, as far as its outside appearance goes, to most amongst us. It is

1. *Lecanium hesperidum;* auctorum.

Plate VI., fig. 12.

The young insect, in outline, is not much different from that of *Mytilaspis pomorum*, with the exception of the abdominal cleft. In colour it is reddish brown; it is flat and very active. The antennæ have six joints, but the fifth joint looks as if it were composed of two soldered together; the third joint is the longest. The last joint has a few hairs. The tibiæ and tarsi are of about equal length; the upper pair of hairs, or digitules, above the claw long, the lower pair short and narrow. The abdominal lobes end in two very long setæ. Plate VI., fig. 12*a*.

The adult female is figured by Westwood (vol. 2), but not large enough for detail. M. Signoret gives only a brief description. The insect is flat, oval, brown in colour, sometimes as much as $\frac{1}{5}$ inch long. The abdominal lobes are not, in the live animal, so apparent as in the young; but when mounted for the microscope they are plainly seen to be without the two long hairs characterising the young insect; as shown in plate VI., fig. 11*b*. The anal ring is surrounded by six long hairs. The lobes are triangular, with rounded angles, or heart-shaped.

The antennæ, which do not, as in the Diaspidæ, disappear with age, have seven joints; fig. 12*b*. The first and second joints are the thickest;

the third, fourth, and seventh the longest, and about equal to one another; the fifth and sixth somewhat shorter. There are a very few hairs on most of the joints, but the seventh has a good number.

The feet are moderately long; the coxa thick, the femur moderately large and about the same length as the tibia which is somewhat thinner, the tarsus still narrower, tapering to the claw. The upper pair of digitules above the claw are pretty long, ending in a very small knob; the lower pair are about twice the length of the claw, very broad.

The general outline of the body (fig. 12*c*) is oval, but varying in eccentricity. On the holly and ivy in our gardens it forms a pretty regular ellipse; on the Portugal laurel it is more elongated; on the orange nearly circular. It is covered with minute specks, and a row of small hairs, not very close together, runs round the edge. There are four stigmata, as shown in plate VI., fig. 10*c*, and opposite each, at the edge, is a depression with three strong spines, of which the middle one is much longer than the other two. At certain stages of the life of the insect, on lifting it from the leaf, cottony trails may be seen on the plant marking the position of these stigmata, an appearance usual, according to Signoret, amongst the Lecanidæ.

The male of this species is unknown.

Lecanium hesperidum is said to be always viviparous. In the Diaspidæ, the female lays her eggs in a prepared nest; in the Lecanieæ she becomes herself the nest of her young. About April, in this country, on turning over one of the females, it will be seen that on the under side of the body, there is a broad deep-red cavity, between which and the leaf numerous young ones run briskly about. Inserting the insect into some transparent fluid, such as glycerine or balsam, the body is seen to be full of eggs; but, with the exception of some minute white objects amongst the brown young ones which might be remains of shells, no eggs are visible outside her. I am unable to account for the blood-red colour of the cavity. Signoret speaks of it as "a mortified spot;" but it sometimes occupies nearly half the under surface of the body, and at the same time the insect is not dead. The interior substance, which, in mounting for the microscope, is pressed out of the body, is not red but yellowish brown.

This insect is becoming a veritable pest in this country. Hollies, ivies, Portugal laurels, and many other trees in our gardens are every year becoming more and more infested with it. Whatever may be the chances of keeping it down in greenhouses, it is to be feared that a cure for plants out of doors is next to impossible.

2. *Lecanium depressum*, Targioni.

This is an European species, occurring here in our greenhouses. The adult female is oval, not so flat as *Lecanium hesperidum*, and with the skin curiously marked with a mosaic pattern.

3. *Lecanium hibernaculorum*, Targioni.

Also European; the body, in its later stages becomes quite rounded or bag-shaped, the open mouth of the bag downwards on the leaf. The bag becomes filled with eggs and young. The skin is marked with small spots at pretty regular distances. It is common in our greenhouses.

4. *Lecanium maculatum*, Signoret.

European; occurring here on a hothouse plant, *Bavardia.* The species is distinguished by a row of oval spots commencing above the abdominal lobes and extending up the centre of the dorsal region as far as the rostrum.

I need not dwell longer on the species of Lecanieæ; there are others here, but European. Nor shall I dwell upon the next subsection on my list.

II.—Pulvinarieæ.

As far as my observation has extended, this subsection is confined here to one species, namely, the *Camellia* scale.

5. *Pulvinaria camellicola*, Signoret.

The insect, which is European, differs from *Lecanium hesperidum* chiefly in its mode of propagation. Instead of producing the young beneath itself it forms elongated cocoons of white cottony fibre in which it encloses its eggs. I have not been fortunate enough to procure a male, although, as I understand, it is not rare.

III.—Lecanio-diaspidæ, Targioni.

I come now to my third subsection, containing in this country only genera and species which are, as I believe, new to science. The subsection itself has been created by Professor Targioni-Tozzetti, of Florence, in order to include those genera of Coccidæ which partake of the characters of the Lecanidæ and of the characters of the Diaspidæ. They have the mentum and abdominal lobes of *Lecanium*, but they are surrounded by a shell, shield or test, as in *Diaspis.* This test or carapace is therefore a character clearly distinguishing them from the other Lecanidæ which have the body naked in all its stages; at the same time the abdominal lobes forbid their entrance into any other group.

It would appear that Professor Targioni makes one of the distinguishing characters of this subsection the fact that the insects lose their limbs like the Diaspidæ, "becoming apodous in the adult stage." Now the genera and species which I have to describe do not all entirely agree with this account. The feet and antennæ are preserved at least until the female has propagated her young and sometimes still later, although in other instances I have been unable to detect the limbs in the later stages. To the naked eye, indeed, or even with a low power of the microscope, all the insects appear apodous; but a higher power often reveals the limbs as if buried in the fat body. It seems to me that I have therefore only two alternatives:

either to create a new subsection, or to attach so much elasticity to the existing classification as to allow these species to belong to the *Lecanio-diaspidæ.* I am loth to take the former course, because in their other characters they present little difficulty; moreover, the context of the expression quoted above is not entirely free from doubt. I shall therefore proceed upon the second course.

I have already said that the insects in this subsection combine the mentum and lobes of Lecanium with a test or carapace as in the Diaspidæ. In the species before me this test is whitish, glassy, and transparent in the earlier stages, often waxy on the old insects. A fringe more or less broad, and divided into segments more or less large, is seen in most species; and the old female, after having produced her young, is generally found shrivelled up at the cephalic end of the test.

Spinnerets are not to be made out in the earlier stages, but when the insect is fully grown there may be seen, all round the edge of the body, a row of numerous circular openings, and, especially in *Ctenochiton viridis*, other rows of minute oval marks disposed along the borders of scales like those of a tortoise. I imagine that these marks are the spinnerets.

In this subsection I have two genera, both of which I believe to be new.

CTENOCHITON, gen. nov.

Four genera are included by Signoret in the subsection Lecanio-diaspidæ :—

1st, *Pollinia*, in which the test is globular, and the young insect presents, instead of the abdominal lobes of *Lecanium*, the anal tubercles of *Coccus.*

2nd, *Asterolecanium*, in which the fringe is double, and the females in most cases apodous.

3rd, *Planchonia*, in which the test is felted, the adult female without feet or antennæ.

4th, *Lecanio-diaspis* in which the test is also felted, but the female retains her antennæ.

It will be seen that my genus *Ctenochiton* does not agree with any of these. The young insect has the abdominal lobes; the test is glassy and transparent, becoming waxy at a later period and, in one species, felted at the latest stage; the females preserve their feet and antennæ at least until after producing the young.

6. *Ctenochiton perforatus*, sp. nov.

Plate VII., figs. 13, 14.

This species is very common upon native trees and shrubs near Christchurch. *Pittosporum*, *Drimys*, *Coprosma*, *Rubus*, *Panax* and many others are attacked by it, sometimes so much so that the underside of the leaves is scarcely to be seen for the number of insects covering them.

The young, on leaving the parent, resembles that of *Lecanium hesperidum;* in fact I can see no difference except that perhaps one of the hairs on the last joint of the antennæ is longer in this species. The antenna has six joints, on the last of which are eight fine hairs.

In its next stage the female insect is extremely thin, appearing on the leaf like a translucent blueish film; so thin indeed that some care is necessary to detach it unbroken from the plant. Sometimes so many of these films are seen together as to give quite a slimy appearance to the under side of the leaf. Plate VII, fig. 13*a*, shows the appearance of the insect at this stage. The toothed fringe is here seen as closely attached to the body; it is very difficult, if not impossible, to detach it mechanically at this stage. Upon immersion, however, in turpentine or spirits of wine and then in Canada balsam the test seems to become dissolved, and with it disappears the fringe, leaving the insect as shown in fig. 13*b*.

It will be seen that the outline of the body is elliptical, but instead of presenting a regular curve as in *Lecanium hesperidum* the edge shows a number of re-entering curves, giving a wavy appearance. This peculiarity is noticeable to a greater or less extent in all the species of the present subdivision which I have observed; and I am somewhat inclined to think that it might be taken as a distinguishing characteristic of the New Zealand *Lecanio-diaspidæ.*

The rostrum and mentum are of the usual kind. The antennæ have seven joints (fig. 13*c*); the third much the longest, the two first short and broad, the fourth rather less than the fifth which is again rather less than the sixth, the sixth about equal to the seventh which has a few long hairs. The legs have the coxæ very thick, the femora thick and not very long, the tibiæ and tarsi narrow and of about equal length. The claw (fig. 13*d*) has the upper digitules very long, with a minute knob, the lower pair shorter, and not nearly as broad as in *Lecanium hesperidum.* The abdominal lobes are as usual, and the anal ring has six or eight long hairs.

Opposite the stigmata are spines, as in all Lecanidæ, and several short hairs are placed all round the edge.

The eyes appear as small red granular spots placed in front of the antennæ.

It is not until the female insect has entered upon a later stage that the character of the test or carapace can be made out. An insect taken towards the end of summer, say in February, can be easily detached from its test; and in the autumn and winter a large number of tests, empty, may be seen on the leaves. The female herself does not, I think, undergo a change, except that she has increased in size and thickness and is full of eggs. She appears circular in outline, somewhat convex, with an average diameter of

$\frac{1}{6}$ inch. A rather broad edge runs round the body, on the interior of which are seen the numerous circular openings of the spinnerets. The antennæ and feet do not seem to have changed. There is a small quantity of white cottony fibre visible on the under side, but the general appearance is rather leathery.

The test, detached from the insect, is seen to have become thicker and more solid than on the young female. It has now the appearance not of a translucent film but of a thin cake of cloudy wax. It is still extremely brittle, but it does not dissolve when immersed in Canada balsam. The whole of the central space, as shown in fig. 13*e*, is seen to be divided into segments, irregular in shape, of which the row along the middle may be said to be roughly hexagonal, having next to it on each side a row of elongated pentagons with apices turned outwards and then a third row of pentagons with their bases outwards, with a few triangular segments filling up the spaces. The divisions between the segments are somewhat thickened, and along each runs a line of very small oval marks, possibly spinneret orifices. I have not, in this species, observed any symmetrical markings on the interior segments, a feature which, I think, distinguishes the next species on my list.

The apices of the first row of pentagons reach nearly to the edge of the solid part of the test. The bases of the second row form the edge itself, and are in juxtaposition to the segments of the fringe, which are much the same as in the earlier stage. In this outer row of pentagons, however, and in the fringe are observable certain peculiar markings, shown in figs. 13*e* and 13*f*. I am not aware of the use of these, which appear to be produced by rows of perforations containing air. The effect of them is not without beauty.

In autumn the female is seen in her last stage. Having produced all her young she becomes shrivelled up at the cephalic end of the test in a shapeless mass, in which the legs, antennæ and abdominal lobes can be distinguished with difficulty.

The male of this species is by no means uncommon. In the spring a large proportion of males will be found under tests similar to those of the female. The insect is shown in plate VII., fig. 14*a*.

The head is somewhat rounder than those of the Diaspidæ. The eyes are small and granular, and there are four pairs of them. The antennæ, fig. 14*a*′, are placed at the anterior part; they are long, having nine joints, of which the first is very short and thick, the second thin and rather longer, the three next each about twice as long as the second, the remainder equal to the second and to each other. Every joint has numerous hairs.

The coxæ are thick, the femora longer and more slender, the tibiæ still longer and thinner, broadening a little to the tarsus which is not quite half

as long, and tapers slightly to the claw. All the joints are hairy. The upper digitules are not long, and the knobs small; the lower pair are only hairs.

The thoracic band occupies nearly the whole width; the wings are broad and elliptical, with a single nervure of two branches. The abdomen, somewhat long, ends in a single spike shorter than that of the Diaspidæ.

This species is very much infested by a hymenopterous parasite which takes advantage of its test to lay therein its eggs. A very large number of tests will be found to contain, not their proper insects, but pupæ of this parasitic fly which might possibly be mistaken for males of *Ctenochiton.* I have been able to follow the transformation of the parasite, which appears to be one of the Proctotrupidæ and which I have described in a short paper read before you to-night.*

7. *Ctenochiton viridis*, sp. nov.

The differences between this and the last species are not, I think, noticeable in the earlier stages, except that the insect when first appearing on the leaf with its fringe has not so much of the filmy look of *C. perforatus*, but is yellower and somewhat more solid. The divergence is more apparent in the stage of propagation, when *C. viridis* attains a much larger size. The female insect has then a bright green colour, is sometimes ½-inch long and ¼-inch wide and pear-shaped, acuminate at the cephalic end. It has a repulsive appearance on the underside of the leaf where it forms a depression corresponding to its body. I have found it abundant on *Coprosma*, *Panax*, and *Rubus*, near Christchurch, in Riccarton Bush.

The test, in the earlier stage, resembles that of *C. perforatus*, being glassy, with a fringe of broad segments. At the later stage the fringe disappears, and the test, instead of being easily removable as in the last species, becomes intimately attached to the insect, so that in order to examine it one has to tear and wash away the body and internal organs. When this is done it is seen that the rows of segments are more numerous than in *C. perforatus*, the segments themselves smaller, and the oval markings on the dividing lines in double rows. Moreover, each segment is marked by radiating straight lines crossed by wavy curves, giving it an appearance something like the scale of a fish. These lines are not clearly to be made out after immersion in a fluid, such as glycerine or Canada balsam.

The fringe is absent at this stage, and there is no sign of the lines of perforations characteristic of the last species.

The appearance of a segment of the test is shown in plate VII., fig. 14*b*.

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* *Vide* Art. XVII.

The antennæ and feet do not, as long as the fringe is present, differ from those of *C. perforatus*. In the later stage, when the insect has attained its full size, they become very small proportionately, indeed almost atrophied, and difficult to make out. Maceration in potash shows them as existing, but they can be of no use to the insect. I cannot detect any difference between them and the antennæ and feet of *C. perforatus*, except their comparative smallness.

The edge of the female in the earlier stages presents the usual wavy outline which I referred to just now.

In its last stage the female is enclosed in a thick coat of whitish-cottony felted fibre. The feet and antennæ are only to be made out after prolonged maceration in potash. The whole mass inside the felted matter is dirty-brown in colour, leathery in texture, preserving the acuminate pear-shape of the last stage.

When arrived at this condition the insect appears on leaves of *Panax*, *Rubus*, *Coprosma*, etc., like splashes of birds' dung, giving the leaf a peculiarly nasty look.

I have not found the male insect.

8. *Ctenochiton elongatus*, sp. nov.

Plate VII., fig. 14.

I obtained this species in Auckland, on *Geniostoma ligustrifolium*. I have only the female, in one stage. The body is very much more elongated than in the last species, the width being not more than a quarter of the length; the edge of the body is, as usual, wavy; the stigmatic spines very prominent.

The antennæ and feet resemble those of *C. perforatus*, but I can detect no lower digitules.

The fringe, which disappears in Canada balsam, differs from that of *C. perforatus* in the absence of the perforations and in the shape of the segments. Instead of the perforations there seem to be transverse wrinkles, and the segments are not roundly triangular but quadrate outwardly, their inner apices pointed; see plate VII., fig. 14*d*. The remainder of the test is divided into quadrangular scales. The whole test is extremely delicate and transparent.

9. *Ctenochiton spinosus*, sp. nov.

Plate VII., fig. 15.

I have this species from *Atherosperma novæ-zealandiæ*. The female is brown, oval, about $\frac{1}{30}$ inch long, the edge slightly wavy. The antennæ are thick, with seven joints, all nearly equal in length; the third joint is somewhat the longest; the seventh has a few hairs; plate VII., fig. 15*a*. The

feet are long; the coxa thick, femur thick and twice as long, tibia and tarsus narrow but equal in length to the femur; upper digitules short; I have not seen the lower pair. Fig. 15*d*.

The abdominal lobes, rostrum and mentum as usual.

The body, fig. 15*b*, is edged with a row of strong bristly spines, seemingly hollow, starting each from a distinct tubercular root, and set close together. Each spine is slightly curved, and the whole row gives the insect something of the look of *Dactylopius citri*, Signoret, a similarity which is at once seen to be deceptive on comparing the species.

The test is thin and waxy, and does not appear to be subdivided into segments as in *C. perforatus;* but my specimens are so much covered with fungoid growth that I cannot make this out with certainty. The fringe is composed of feather-like segments, much narrower than in the other species. Each feather corresponds to, and covers, a spine of the body. See figs. 15*b* and 15*c*.

I have not a specimen of the male.

I COME now to another genus, which I believe to be also new. It was brought to me first by Mr. J. Inglis, from whom I have named it; but I have since found it on *Coprosma* in Riccarton Bush.

I include this genus in the Lecanio-diaspidæ, on account of the test and the presence of the abdominal lobes, but it differs from *Ctenochiton* in the shape of the test and the absence of segmental fringe.

INGLISIA, gen. nov.

I have as yet only one species of this genus, which presents one or two remarkable characters. Exteriorly it resembles very much in shape a limpet, from which I have given it the specific name of

10. *Inglisia patella*, sp. nov.

Plate VII., fig. 16.

The test is whitish, glassy, limpet-shaped, marked with radiating striæ; the striæ, on examination, prove to be composed of rows of oval perforations containing air. They give to the test, which is composed of several corrugations, a very elegant appearance—fig. 16*a*. The insect, test and all, reaches $\frac{1}{12}$ to $\frac{1}{15}$ inch in diameter. The height is about one-third of the length.

The female insect, fig. 16*f*, corresponds in shape to the test, filling it entirely. In this state the antennæ and feet are scarcely to be made out, but on maceration in potash and subsequent pressure the underside presents the appearance shown in fig. 16*b*. The wavy edge spoken of above is here visible, and it is seen that the curves of the body correspond with the corrugations of the test. The antennæ are very short, and, as far as I have observed, have only six joints, but I may be in error in this, as the *Lecanidæ*

have almost all seven-jointed antennæ in the adult. The second joint, fig. 16*c*, is very short, the third the longest, the fourth, fifth and sixth about equal in length; the last three have some hairs. The feet, fig. 16*e*, have the femur thick and strong, tibiæ rather longer and thick, tarsus still longer and thin; the upper digitules very long, the lower pair narrow, about twice as long as the claw. The edge of the body is surrounded with a row of small spines, of which each alternate spine is pointed (fig. 16*d*), the remainder club-shaped. The abdominal lobes of the *Lecanidæ* are present, but the cleft is different from that of any other species. The abdomen, as shown in figs. 16*b* and 16*d*, ends in a pair of narrow curved protuberances, nearly meeting at their ends, but separated above by a broad open space in which the two abdominal lobes are seen protruding. The row of alternate spines does not extend round this space. The anal ring has eight long hairs.

The edge of the body shows a double line, like a ribbon, in which are set the alternate spines. Inside this is a row of spinnerets with, on the inner side, a line of short curves. . The edge itself is crenated.

The female in the stage immediately preceding that which I have described, and before covering itself with the test, resembles somewhat the female of *Ctenochiton*, as given in plate VII., fig. 13*b*. The outline of the body is much the same, with the four spiracular spines, and the alternate pointed and clubbed spines are absent. But, on close examination, it cannot be mistaken for *Ctenochiton*, as the antennæ are shorter and thicker, and the abdominal cleft already shows signs of the peculiar shape assumed in the later stage. Moreover, a commencement of the test may usually be detected, and this is quite different from that of the *Ctenochiton*.

I have not yet found the male of this interesting species which, in outward appearance, has some similarity to *Fairmairia bipartita*, Signoret, but is certainly not the same.

I OUGHT now to proceed to the description of the third great group of Scale Insects, the Coccidæ proper. But I must first give an account of a genus which perhaps should have come into my last paper, but which I had not, at the last meeting of the Institute, made out sufficiently for description.

This genus is somewhat anomalous. It is clearly not belonging to *Lecanium*, nor does it come under the subdivision Lecanio-diaspidæ, as the abdominal lobes are wanting, or rather different. At the same time it has so much likeness to the Lecanidæ that I cannot connect it with any other group. I imagine, then, that the genus is new, and typical, in fact, of a new subdivision, to which I give the name of

ASTEROCHITON, gen. nov.

The genus is characterised by *enclosure* in a test which is so intimately attached to the insect that it cannot be removed without injury. The

specimens which I have obtained from Canterbury, Wellington, and Auckland, although taken at different seasons, in October, July, February, March, and April, show only two forms. The one is the young insect before it becomes covered by the test; the other is apparently an intermediate stage prior to appearance as a perfect insect. In July, on fronds of *Polypodium billardieri*, I have collected great numbers of empty tests, and intermixed with them tests with enclosed insects. It might be assumed that this fact points to the emergence of insects in the perfect state leaving their pupa-cases behind them. But so many of these cases contained the pupæ or the remains of the pupæ of parasitic flies, that it is equally probable that the scale-insect had been devoured. I hope to obtain, ere long, specimens of other stages of this insect; meanwhile, as there is no doubt that, in the stages which I have observed, it differs considerably from any other genus, I shall proceed to describe it.

In the Lecanio-diaspidæ the test does not entirely enclose the insect, which is, on the underside, free. *Ctenochiton viridis*, which I described in my last paper, becomes in its later stages closely attached to its test, and in its last form of all enveloped in a cottony mass. But this last takes place when the insect is practically dead, or dying; indeed, I am inclined to think that the white mass is not the usual cottony web of the Coccidæ but fungoid. *Asterochiton*, on the other hand, in the specimens I have seen, is entirely shut up in its test; even the feet are useless to it, being enclosed. All that emerges is the mentum with its suctorial setæ; and it is this which prevents me from considering the insect as being in a pupa state. If it were a pupa I imagine that it would not require to feed, and the mentum would be enclosed like the other organs.

This genus, I may observe, cannot well belong to any of those described by M. Signoret, under his subdivision Lecanio-diaspidæ, such as *Pollinia*, *Asterolecanium*, as in those the young insect has the abdomen ending in two protruding tubercles, which in this genus is not the case.

I have two species of the genus.

1. *Asterochiton lecanioides*, sp. nov.

Plate VII., fig. 17.

Common near Christchurch, on *Pittosporum eugenioides* and *Polypodium billardieri.*

The young insect is extremely minute, and requires great care to mount. It is oval (plate VII, fig. 17*a*), greenish gray in colour, the outline smooth, with the four spiracular spines of the Lecanidæ; at the posterior end are six long hairs, of which the two middle ones are the longest. The eyes are red, comparatively large, granular, and set somewhat far back; the anal marks resemble those of the adult. I have not been able to make out the antennæ and feet.

With a very high power of the microscope the commencement of the test may be observed, which in the next stage envelopes the insect. Here, as shown in fig. 17*b*, the outline is still oval, but the edge is slightly crenated; there are now only four hairs at the posterior end and these are short. The insect is evidently quite enclosed in the test. There is an indication of the abdominal cleft, but it is only a sort of groove, and the abdominal lobes are replaced by a sort of vase-shaped organ. It is possible sometimes to mount a specimen so that the sight is not wholly impeded by the test, and it is then seen that the antennæ are short and the legs thick, but I have not been able to make out the joints of either satisfactorily. Round the edge runs a row of cup-shaped spinnerets, and a number of others, sometimes protruding in form of tubes, are scattered over the body.

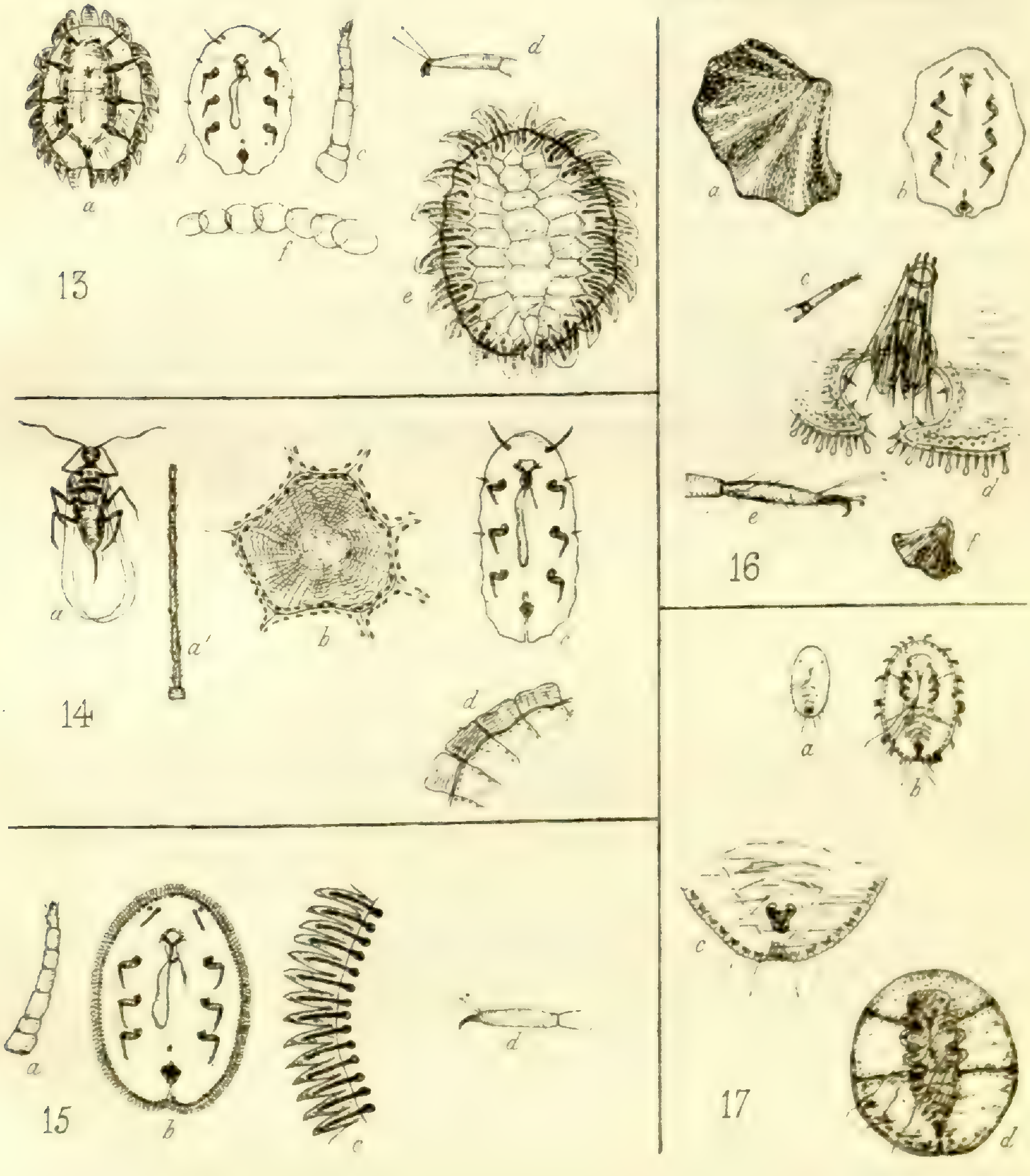
Later on, although the insect appears not to have entered any further stage, the tests are very frequently found empty. This may be attributed to the action of parasitic flies, for the tests commonly enclose either the pupæ or the pellicles of these, the scale insect having disappeared. The tests are white and glassy, and over them are scattered, chiefly round the edge, tubular appendices corresponding to the spinnerets on the body of the insect. Sometimes these tubes are set so close together that they are straight and have the appearance of a fringe, but as a rule they are irregularly set and curled in different directions.

2. *Asterochiton aureus*, sp. nov.

Plate VII., fig. 17.

I have this species from *Melicytus ramiflorus* at Auckland. It differs from the last in being of a golden or orange colour, the insect in the middle being purple. The outline is also more inclined to be circular, the size is larger, the test is somewhat thinner and allows the insect to be better seen, the groove at the posterior end is deeper, and the rows of spinnerets more numerous. I have not observed in this species any protruding tubes. The antennæ and legs, so far as I have been able to make them out, seem to resemble those of *A. lecanioides*. Fig. 17*d*.

I pass now to the description of the Coccidæ proper. This group contains several subdivisions, but, as heretofore, I shall confine myself to those which appear to me to be indigenous. The differences between many of the subdivisions are not to be detected without the microscope, depending as they do upon the number of joints of the antennæ, number of anal hairs, number of digitules, etc. As for the species which I have collected here I have had a good deal of difficulty in deciding sometimes whether they differ or not from European species; and even now I am not, in some cases, certain.



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The general characteristics of the group are as follows:—the females are of all shapes and colours, usually covered with a mass, more or less thick, of cottony or waxy secretion, but not, as a rule, enveloped in glassy tests like the Lecanio-diaspidæ. The mentum differs from that of the Lecanidæ in being bi- or tri-articulate. The abdominal lobes of *Lecanium* are absent, and the posterior end is not cleft; but the body ends in two protuberances, more or less developed and prominent, which I shall call the "anal tubercles." These tubercles usually terminate in fine hairs, sometimes long, sometimes short. The tubercles are not always easily detected, but close examination reveals them. The segments of the body are much more visible than in the Lecanidæ, and the insect has altogether a more woolly appearance. In some genera the female envelopes herself in a cottony sac, white or yellow.

The males are not uncommon; but I have not been able to procure many specimens. They do not greatly differ from those of the Lecanidæ, but in my specimens the abdominal spike is accompanied by a shorter curved spike at the side.

The subdivisions of this group to which my specimens belong are:—

1. *Acanthococcus*, of which I have specimens from the common broom plant and from *Budlæa*.
2. *Eriococcus*, from the Norfolk Island Pine.
3. *Dactylopius*, from *Rubus australis*, *Pittosporum*, *Calceolaria* and other plants.
4. *Icerya*, from the Kangaroo *Acacia*.

All these contain species known in Europe, from which mine, I believe, differ.

I. ACANTHOCOCCUS, Signoret.

The subdivision is characterised by an elongated sac, usually brownish yellow, enveloping the female, by the prominence of the anal tubercles, and by the number of rows of conical spines distributed over the body. One species is known in Europe. I give to my specimen the name of

Acanthococcus multispinus, sp. nov. (?)

Plate VIII., fig. 18.

The sac, fig. 18*a*, is dull yellow, nearly cylindrical, one end closed with a curve, the other open. It is composed of interlacing cottony fibres. The female insect, fig. 18*b*, is of an elongated oval form, the widest part being near the posterior end. It is dull pink in colour, covered thinly with whitish meal. The segments of the body are not very distinct. The anal tubercles are plainly visible, and between them is a pencil of white meal glueing together the long hairs of the anal ring.

After mounting for the microscope and expressing the interior substance, the insect is seen, as in fig. 18*c*, to have several rows of large conical spines,

which distinguish it from the next genus which has but two or three rows, and from the European species which has six. Besides these there are a number of spinnerets secreting the cottony meal, and many of these protrude as tubes of peculiar shape, as shown in fig. 18*d*. The antennæ, fig. 18*e*, have six joints, the third the longest, the fourth and fifth equal to each other and nearly round. The legs have the tibia somewhat shorter than the tarsus, the upper digitules are pretty long, the lower only short hairs.

The male insect is orange red, with long wings, undergoing its transformations in a sac resembling that of the female. The antennæ have ten joints, of which the fourth, fifth, sixth, and seventh are long; the second, third, eighth, and ninth wider and globular; the tenth globular but smaller. The hook of the foot is long; the abdominal spike, fig. 18*f*, is short and thick, with a curved appendage.

II.—Eriococcus, Targioni.

This subdivision also has a sac, but it is usually less elongated than in the last, and white in colour. My species, to which I give the name of

Eriococcus araucariæ, sp. nov. (?)

is found on the Norfolk Island pine at Governor's Bay, but I am by no means certain that it is indigenous. The female insect differs from the last described only in the number of the conical spines, of which there is usually only one row round the edge, though in some specimens a few scattered spines may be seen elsewhere. It appears to resemble greatly *E. buxi*, Signoret, and I doubt whether it is a new species; at the same time, the anal hairs are only six in number as against eight in *E. buxi*, and the lower digitules appear to be much smaller. I therefore provisionally consider it a distinct species.

I have a specimen of the male, not in its perfect state but as a pupa upon the point of undergoing transformation. It appears to differ somewhat from that of *Acanthococcus*, but I am unable to say how far it differs from *E. buxi*.

III.—Dactylopius, Signoret.

The females of this subdivision have eight-jointed antennæ, the anal tubercles less prominent than in the two foregoing, and usually a series of cottony appendages running all round the edge ef the body, increasing in length at the posterior end.

The differences between my species and those described in Europe are not, in some cases, great, yet they are such as induce me to set down my New Zealand specimens as distinct species.

Dactylopius calceolariæ, sp. nov. (?)

Plate VIII., fig. 19.

This insect is effecting great destruction in the public gardens in Christchurch amongst the calceolarias, and upon several native plants such as

Traversia, *Cassinia*, etc. I am glad to say that the gardener, Mr. Armstrong, has seen the little white-eyes *(Zosterops)* busily engaged in picking them off the plants.

The general form of the female is shown in plate VIII., fig. 19*a*. It is pink in colour, covered with white meal. It resembles in several particulars some of the *Dactylopii* described by M. Signoret, but, either in the antennæ, or in the feet, or in the appendages, differs from them all. The body is pretty regularly oval, the segments very distinct; the appendages are short except at the posterior end where there are two very long, with, on each side of them, another somewhat shorter. The two longest surround the hairs of the anal tubercles, which are inconspicuous, and between them is visible the white pencil of meal surrounding the anal setæ.

The interior substance of the body, expressed for mounting, appears to be very oily, at least containing great numbers of oil globules. The antennæ, in the adult female, have eight joints, fig. 19*b*, of which the 3rd and 8th are the longest, the 6th and 7th the shortest. Each joint has several hairs. The mentum appears to be tri-articulate, and has a few hairs at its tip; the rostral setæ are long. On the legs the coxa and femur are thick; the tibia, much thinner, is more than twice as long as the tarsus; the upper digitules, fig. 19*c*, are not very long; the lower are narrow and about equal to the claw.

The anal tubercles are inconspicuous; each has a few hairs, of which one is longer than the others, and two conical spines. The anal ring has six hairs. These details are shown in fig. 19*d*.

The young insect differs slightly. The antennæ have six joints, the sixth much longer than any of the others, which are about equal. The tibia is shorter than the tarsus. (According to M. Signoret, this character affords the means of judging the age of any insect of the group Coccidæ. Whenever the tarsus is longer than the tibia the insect is in an early stage). The anal tubercles are somewhat more prominent than in the adult, giving the insect an appearance of having been cut off square at the end.

I have not the male of this species.

Dactylopius glaucus, sp. nov. (?)

This species differs from the last in its colour, which is light green, and in having a less regularly oval line; the abdominal region runs more to a point. The antennæ, feet, etc., resemble those of *D. calceolariæ*. My specimens are from *Pittosporum eugenioides* and *Rubus australis*.

I have one specimen which appears to me to be a male in an early stage. In outline it resembles a female, but the rostrum is absent, and at each side there is a protuberance which seems to me to be the rudiments of the wings.

The abdominal segments overlap each other, tending to the form of abdomen of the male Coccidæ. The antennæ, which are thick, have six joints. The claw of the foot is very small.

Dactylopius poæ, sp. nov.

Plate VIII., fig. 19.

This species is found on the roots of the common tussock grass, or rather on the stems close to the ground.

It is a rather large insect, bright pink in colour, covered with a white meal, and with a very regular oval outline; flat on the underside, convex above. The mentum has a few hairs at the tip; the setæ are long.

The antennæ are very short; the second and third joints are the longest; the last joint has a few hairs. Fig. 19*e*.

The legs are short; the coxa thick, the femur somewhat thinner, the tibiæ and tarsus still less and about equal in length. The upper digitules, fig. 19*f*, are not long, the lower inconspicuous, if not wanting. There are a few hairs on the tarsus.

The anal tubercles are extremely small, scarcely perceptible; each has three conical spines but no hairs, and a few other spines are visible on the abdomen. The anal ring has, I think, six hairs; fig. 19*g*. All over the body are numbers of small circular spinnerets.

I have not the male of this species, which is, I think, certainly new.

IV.—Icerya, Signoret.

My specimens of this subdivision were found on a hedge of the kangaroo acacia, in Auckland, in March last. I understood from Mr. Cheeseman and Dr. Purchas, who kindly brought the insect under my notice, that it had only lately appeared in Auckland, and that it was only, as yet, to be found upon that one hedge. The plants, I may say, were nearly destroyed by the insects, which covered them in great numbers; and the large size and peculiar appearance of the pest were very striking.

The genus *Icerya* belongs to the Monophlebidæ, a family of Coccidæ, which has eleven joints in the antennæ of the female, and ten in the antennæ of the male. There are several genera of these, but the insect before me seems certainly to belong to *Icerya*. There is but one feature, the absence of which in my species may perhaps relegate it to some new genus. M. Signoret says that, after treatment with potash, a tube may be seen above the anal orifice forming a sort of folded ring; this tube he takes to be the oviduct. I have not been able to observe this tube although I have examined several specimens. At the same time all the other features correspond to the description of the genus *Icerya*; and I am not inclined to attempt the formation of a new genus simply on account of the absence of a feature which perhaps I ought to have been able to make out.

Only one species of this genus seems to be known, and that is *Icerya sacchari*, an insect which, in Mauritius, does great injury to the sugar-canes. M. Signoret describes this species, which differs from the one I am describing in a few particulars. First, its general colour is yellow; secondly, its cottony fibres appear to envelope it more completely than in my species; thirdly, the segments of the body are more clearly defined; fourthly, the young insect is more hairy, and the hairs are not similarly arranged; fifthly, the abdomen ends in a trifoliated lobe, which is not the case in my species. I imagine, then, that the insect from Auckland is new, and I take the liberty of naming it after the Rev. Dr. Purchas who, I believe, first found it.

Icerya purchasi, sp. nov.

Plate VIII., figs. 20 and 21.

The eggs of this species resemble those of the other Coccidæ; they are red in colour. The young insect emerging from the nest is reddish, inclining to brown. The body, fig. 20*a*, is oval, hairy, with a quantity of cottony down beginning to cover it. The antennæ have six joints, fig. 20*f*, the first wide and short, the next four a little longer and about equal to each other, the sixth much larger, club-shaped, having apparently four segments joined together. All the joints have a few hairs; on the sixth are several, of which four are very much longer than the rest. The legs are brown, thin. The coxa and femur moderately large, the tibia and tarsus long and thin. The tibia and tarsus have several long hairs. The claw is somewhat long. I am not sure about the upper digitules, but they seem to be only hairs; the lower pair are a little wider, bent like a hook.

The eyes are prominent, tubercular, set behind the antennæ. The mentum, which is broad and thick, seems to be bi-articulate. The rostral setæ are not long.

The abdomen ends in a smooth curve, but at each side of the centre are three small lobes from which start six very long hairs, as long or longer than the body of the insect.

Six rows of spinnerets are seen on the body, four along the middle and one at each side. Alternating with these are rows of hairs.

In its next stage the female insect becomes somewhat altered. Its outline is still oval, but not so regular, and its colour is a darker red, nearly brown, under the white curly cotton which covers it. The six hairs of the abdomen are still visible, but they are much shorter than in the young insect, scarcely appearing beyond the other hairs of the body. Maceration in potash and subsequent mounting get rid both of the interior substance and of the cotton, and the insect is then seen to be much more hairy than the young. The hairs are short, and distributed pretty thickly over the thoracic portion of the body, less thickly on the abdomen; but all round the edge they are placed in tufts close together, each tuft containing twenty or thirty hairs; fig. 20*b*.

The spinnerets are not arranged in rows, but scattered in great numbers over the whole body. The vast majority of them are small and circular, but round the edge of the body, amongst the tufts of hairs, runs a row of others much larger. These protrude some distance from the body; their lower end being brown, with a sort of crown encircling it, from which springs a long glassy tube. Some of these spinnerets and a tuft of hairs are shown in fig. 20*c*.

The feet and digitules, fig. 20*e*, resemble those of the young insect, but the antennæ have now nine joints, all nearly equal, the last joint smaller, comparatively, than in the young; the hairs of the antennæ are also shorter.

In its third stage (fig. 21), the insect acquires its very peculiar appearance and afterwards changes no more. The feet are much the same as before; the antennæ have now eleven joints, tapering slightly to the tip, and all somewhat more hairy than in the last stage; fig. 20*d*. The tufts of hairs are still at the edge; the spinnerets are still more numerous than in the earlier stages.

The general colour of the insect is now a rusty brown, but it is so covered with cottony down as to seem, in the latest period, nearly white. All round the edge, especially at the abdominal end, runs a row of black marks (the tufts of hair spoken of above), and just within it a fainter line. At the commencement of this stage the insect lies flat on the leaf or twig, but its edge is slightly raised all round, whilst along the middle of the upper side of the thoracic portion is a raised hump, or rather a prominence divided into three humps. A white meal covers the back, and all round the edge is seen a narrow ring of white felted cotton. This is the commencement of the large ovisac or nest, in which the young insects are enveloped.

Later on the female begins to procreate. The body becomes full of eggs, and these are ejected into the ovisac, which is gradually becoming larger. The insect now begins to be raised up; the cephalic end still remains attached to the plant, but the abdominal end is elevated, and the space left is filled with the cottony down of the ovisac. At the same time, white cottony processes form at the edge of the thorax, over the feet, looking, in fact, to the naked eye, as if they were actually attached to the legs. Long, fine, translucent white hairs or spines radiate from the body in every direction. The general colour of the insect is still brown, powdered with white.

The female at length reaches her full development. Now the abdominal end is still more raised, so that the insect has the appearance of standing on its head. The ovisac attains its full size, and extends for some distance behind the body, filling also the space between it and the plant, as shown

in fig. 21*b*. In fact the insect is now, as it were, resting on a bed of cottony down, its head downward to the twig. The ovisac, in its upper portion, is divided by regular grooves; the under side is flat, having several short cottony processes radiating from its edge. It is now full of eggs, and these, rapidly hatching, produce the young insects which emerge through the cotton and go to seek their fortunes on the plant. I think the ovisac usually contains from 60 to 70 young insects. The extreme length, from the head of the female to the extremity of the ovisac, is sometimes nearly ⅓ of an inch, the height being about ¼ inch.

I have not been able to find a male insect of this, which is certainly the most curious species of the Coccidæ with which I am acquainted. The male of *Icerya sacchari* is also, I believe, unknown.

I have now completed the description of the species Coccidæ proper, and in fact of all the insects which I am as yet able to relegate to well-defined genera. I have still to describe one species whose position I cannot determine with certainty. It is by no means the least beautiful of the family. My specimens have come from *Pittosporum engenioides* and *Discaria toumatou*. I am constrained to form from it a new genus, which I dedicate to my friend Dr. Powell who was the first to find it.

POWELLIA, gen. nov.

The genus is certainly not one of the Diaspidæ; it does not belong to the Lecanidæ, for it has not the abdominal cleft and lobes and the mentum is tri-articulate, nor to the Coccidæ proper, for there are no anal tubercles, and the feet are clearly different. In some of its characters it bears a resemblance to an Aphidian insect which is very common here upon the young leaves of very young *Eucalypti*, although I do not think that *Powellia* belongs to the Aphides. Is it not possible that it may be a link between the two families *Aphis* and *Coccus*?

Powellia vitreo-radiata, sp. nov.

Plate VIII, fig. 22.

The female insect is shown in fig. 22*b*. It is at once apparent that, in some respects, it has the characters of the Lecanio-diaspidæ; there is the test covering the body and there is the fringe. But further examination shows that it differs a good deal from that group. First, there is an evident division between the test over the thorax and the test over the abdomen; the fringe of the latter is seen to overlap that of the former. Moreover, the eyes are faceted, which is not the case in the Lecanidæ. Again, there is no abdominal cleft.

The first peculiarity of the species is that it seems to have four well defined wings. If this were really the case, as the insect is undoubtedly a female (for it has a mouth), it could not belong to the Coccidæ. But I am

not able to consider these lateral appendages as wings; first, because they start from the head itself and not from the thorax; secondly, because tracheæ may be seen ramifying from the thoracic spiracles through them; thirdly, because in the discarded tests which, in November, can be found pretty numerous, these appendages are very clearly portions of the test itself; fourthly, because the fringe runs round their edges in the same way as on the rest.

The second peculiarity is in the different size of the thoracic and abdominal regions and the clear line of demarcation between them. In the other species of Coccidæ it is difficult, if not impossible, to tell where the thoracic portion of the female ends and the abdominal portion begins. In *Powellia* the division is as distinct as in the males of the other genera.

A third peculiarity is in the feet, which I shall describe presently.

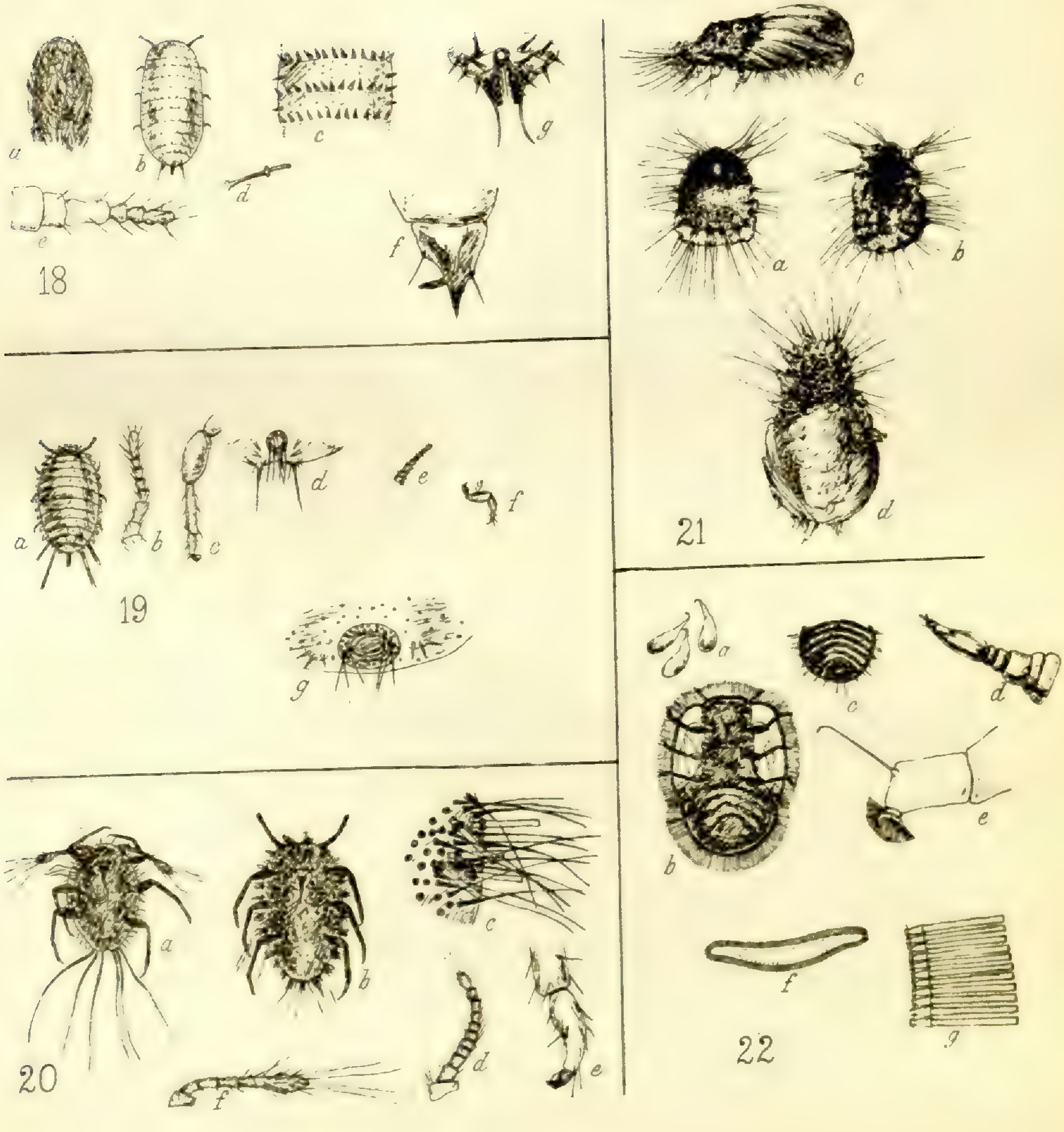
The eggs of this species are bright yellow, tapering to a point at one end; the point appears to be somewhat hooked; fig. 22*a*. They are seen attached in clusters to twigs of *Discaria* and *Pittosporum*.

The young insect is extremely minute, not so large as the dot over the letter *i* in small type. Its colour is brown; the winglike appendages are not distinguishable. The abdomen, which is similar in outline to that of the adult, is marked by six transverse dark bands and a dark patch at the extremity, fig. 22*c*. From each band, at the edge, spring long transparent tubes, in form of fringe, but they are not set so closely together as in the later stages. The antennæ, I think, have only four joints, of which the third is the longest; the fourth joint has two long hairs. The legs are short and very thick; I saw no coxa; the foot resembles that of the adult.

In the next stage the general form is not altered. The bands of the abdomen have become fainter, and the tubes of the fringe are set closer together.

Still later, the insect appears as in fig. 22*b*. This is the last stage which I have been able to observe. The four wing-like appendages are now clearly defined, but, as shown in the figure, five tracheæ ramify from the body through them, and they cannot be considered as wings. The head, thorax and abdomen are distinct. The head, transverse, is oval; the eyes are large, faceted, red in colour. The mentum, tri-articulate, ends in brown toothlike processes. The antennæ have six joints; the first and second very broad and short, the third narrower and longer, the fourth and fifth still narrower and shorter than the third, the sixth very long, somewhat fusiform, with two small spikes at the tip and just above the spikes a long hair.* See fig. 22*d*. The legs are thick and long, set equi-distant on the thoracic region; the coxa and femur very thick, the tibia and tarsus some-

* This long hair is not distinguishable in all specimens.



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what thinner and of about equal length. The tarsus does not taper to the claw as in the other Coccidæ, but is cylindrical, ending, as in fig. 22*e*, as if suddenly compressed and bent downwards. The claw, in which this insect differs from all other Coccidæ, is double, opening like the hooks on the foot of the housefly; it does not spring directly from the tarsus but is set in a sort of ring or socket. At the root of the claw, and spreading over it, is a fan-shaped translucent appendage which is not observable in any other species of the Coccidæ. Above the claw, near the abrupt angle of the end of the tarsus, is a long stiff bristle, slightly curved at the end.

The abdomen, divided clearly from the thorax, is nearly round. The transverse bands seen in the young insect are not now distinct, but may be traced. The anal markings, fig. 22*f*, differ from those of all other Coccidæ. They form an elongated ring on the abdomen, not unlike an Australian boomerang in outline; the outer edge marked like a fine comb, and with a row of small circular spots following the inner contour. I cannot detect any hairs or cilia.

The fringe of this species, which borders the whole test, is very delicate and pretty. It is quite white, glassy and transparent; the threads, very fine, are set close together, and their great length gives to the insect a peculiarly elegant appearance. Under the microscope they are seen to be composed of three parts; a small socket in which is set a vase or cup, and springing from this a long cylindrical glassy tube, apparently open at the end. Very great care is needed in handling the insect, to avoid breaking this very delicate fringe. The cups will remain attached, but the long glass tubes fall off with almost the slightest touch; see fig. 22*g*.

This genus, *Powellia*, presents so many anomalies, in its general shape, in the wing-like appendages, in the divisions of the body, in the shape of the antennæ, the peculiar foot and the abdominal markings, that it scarcely seems related to the members of the family of the Coccidæ. On the other hand it has many affinities with the family, and it will fitly conclude the series of papers which I have been able to draw up this year. I feel sure that there must be many species of Coccidæ yet to be discovered in New Zealand; perhaps at some future time I may be able to describe them.

DESCRIPTION OF PLATES, V.—VIII.*

COCCIDÆ.—Plate V., figure, 1.—DIASPIDÆ.

Fig. a, *Mytilaspis pomorum*: portion of puparium, showing discarded tests of first two stages: magn. 40 diams.

b, *Mytilaspis pomorum*: puparium, female with eggs: magn. 25 diams.

* The measurements are one-third less than stated, the original drawings having been reduced.

Fig. c, Young insect: magn. 60 diams.
d, *Mytilaspis pomorum*: abdominal region: magn. 60 diams.
e, Rostrum of Diaspidæ, natural state: magn. 60 diams.
,, Rostrum, mounted: magn. 60 diams.

Coccidæ.—Plate V., figure 2.—Diaspidæ.

Fig. a, *Mytilaspis pomorum*: eggs: magn. 60 diams.
b, ,, ,, adult female: magn. 60 diams.
c, ,, ,, pygidium of female: magn. 200 diams.
d, a pinneret: magn. 700 diams.

Coccidæ.—Plate V., figure 3.—Diaspidæ.

Fig. a, *Mytilaspis pyriformis*: puparium: magn. 25 diams.
b, ,, ,, adult female: magn. 60 diams.
c, ,, ,, pygidium: magn. 200 diams.

Coccidæ.—Plate V., figure 4.—Diaspidæ.

Fig. a, *Mytilaspis cordylinidis*: puparium: magn. 25 diams.
b, ,, ,, adult female: magn. 60 diams.
c, ,, ,, pygidium: magn. 200 diams.

Coccidæ.—Plate V., figure 5.—Diaspidæ.

Fig. a, *Mytilaspis drimydis*: adult female: magn. 60 diams.
b, ,, ,, pygidium: magn. 200 diams.
c, ,, ,, pupa of male: magn. 25 diams.

Coccidæ.—Plate V., figure 6.—Diaspidæ.

Fig. a, *Aspidiotus epidendri*: puparium of female: magn. 60 diams.
b, ,, ,, adult female: magn. 60 diams.
c, ,, ,, pygidium of female; magn. 200 diams.
d, ,, ,, pupa of male from cocoon: magn. 60 diams.

Coccidæ.—Plate VI., figure 7.—Diaspidæ.

Fig. a, *Aspidiotus atherospermæ*: adult female: magn. 60 diams.
b, ,, ,, extremity of abdomen: magn. 200 diams.
c, ,, *dysoxyli*: female, 2nd stage: magn. 60 diams.
d, Abdomen of adult female: magn. 200 diams.

Coccidæ.—Plate VI., figure 8.—Diaspidæ.

Fig. a, *Aspidiotus aurantii*: adult female: magn. 60 diams.
b, ,, ,, extremity of abdomen: magn. 200 diams.
c, ,, ,, male: magn. 60 diams.

Coccidæ.—Plate VI., figure 9.—Diaspidæ.

Fig. a, *Diaspis boisduvalii*: adult female: magn. 60 diams.
b, ,, ,, cocoon, with male emerging: magn. 40 diams.
c, ,, *rosæ*: adult female: magn. 60 diams.

Coccidæ.—Plate VI., figure 10.—Diaspidæ.

Fig. a, *Diaspis gigas*: female shrivelled after egg laying: magn. 40 diams.
b, ,, ,, pellicle of 2nd stage of female: magn. 40 diams.
c, ,, ,, abdomen of adult female: magn. 200 diams.
d, ,, ,, male: magn. 40 diams.
e, *Diaspis* —— ?: female: magn. 90 diams.

COCCIDÆ.—Plate VI., figure 11.—LECANIDÆ.

Fig. a, Rostrum and mentum of Lecanidæ: magn. 90 diams.
b, Abdominal cleft, and lobes, and anal ring of ditto: magn. 60 diams.
c, Respiratory organ of *Lecanium.*
d, Stigma, and stigmatic spines of ditto: magn. 200 diams.
e, Foot and digitules of ditto: magn. 200 diams.

COCCIDÆ.—Plate VI., figure 12.—LECANIDÆ.

Fig. a, *Lecanium hesperidum*: young insect: magn. 90 diams.
b, " " antenna of adult: magn. 200 diams.
c, " " adult female: magn. 15 diams.

COCCIDÆ.—Plate VII., figure 13.—LECANIDÆ.

Fig. a, *Ctenochiton perforatus*: female, 2nd stage: magn. 40 diams.
b, " " ditto without the test: magn. 40 diams.
c, " " antenna: magn. 200 diams.
d, " " foot: magn. 200 diams.
e, " " test of adult female: magn. 20 diams.
f, " " perforations of fringe: magn. 200 diams.

COCCIDÆ.—Plate VII., figure 14.—LECANIDÆ.

Fig. a, *Ctenochiton perforatus*: male: magn. 25 diams.
a′, " " antenna of male: magn. 60 diams.
b, *Ctenochiton viridis*: segment of test: magn. 40 diams.
c, *Ctenochiton elongatus*: adult female: magn. 40 diams.
d, " " portion of fringe of test.

COCCIDÆ.—Plate VII., figure 15.—LECANIDÆ.

Fig. a, *Ctenochiton spinosus*: antenna of female: magn. 200 diams.
b, " " adult female.
c, " " spines, with fringe: magn. 200 diams.
d, " " foot of female: magn. 200 diams.

COCCIDÆ.—Plate VII.. figure 16.—LECANIDÆ.

Fig. a, *Inglisia patella*: test, or shield: magn. 60 diams.
b, " " adult female, after treatment with potash: magn 60 diams.
c, " " antenna: magn. 200 diams.
d, " " abdomen, showing alternate spines: magn. 200 diams.
e, " " foot: magn. 200 diams.
f, " " adult female, external appearance: magn. 25 diams.

COCCIDÆ.—Plate VII., figure 17.—LECANIDÆ.

Fig. a, *Asterochiton lecanioides*: young insect: magn. 60 diams.
b, " " female in test: magn. 40 diams.
c, " " abdomen of female: magn. 90 diams.
d, *Asterochiton aureus*: female in test: magn. 40 diams.

COCCIDÆ.—Plate VIII., figure 18.—COCCIDÆ.

Fig. a, *Acanthococcus multispinus*: sac: magn. 25 diams.
b, " " female: magn. 40 diams.
c, " " part of female, with spines: magn. 60 diams.
d, " " a spinneret: magn. — diams.
e, " " antenna of female: magn. 200 diams.
f, " " anal spike of male: magn. 200 diams.
g, " " anal tubercles of female: magn. 100 diams.

Coccidæ.—Plate VIII., figure 19.—Coccidæ.

ig. a, *Dactylopius calceolariæ*: female; magn. 20 diams.
" " antenna: magn. 60 diams.
, , " foot: magn. 60 diams.
d, , " anal region: magn. 90 diams.
Dactylopius poæ: antenna: magn. 60 diams.
, " " foot; magn. 60 diams.
g, " " anal region: magn. 200 diams.

Coccidæ.—Plate VIII., figure 20.—Coccidæ.

Fig. a, *Icerya purchasi*: young insect: magn. 40 diams.
b, " " female, 2nd stage: magn. 20 diams.
c, " " hairs and spinnerets: magn. 200 diams.
d, " " antenna, 3rd stage: magn. 40 diams.
e, " " foot, 3rd stage: magn. 90 diams.
, " " antenna of young: magn. 90 diams.

Coccidæ.—Plate VIII., figure 21.

Fig. a, *Icerya purchasi*: female, commencement of last stage, viewed from above: magn. 6 diams.
b, *Icerya purchasi*: ditto, under side: magn. 6 diams.
c, " " female, end of last stage: magn. 6 diams.
d, " " ditto, under side.

Coccidæ.—Plate VIII., figure 22.

Fig. a, *Powellia vitreo-radiata*: eggs: magn. 150 diams.
b, " " female: magn. 25 diams.
c, " " abdomen of young: magn. 90 diams.
d, " " antenna: magn. 100 diams.
e, " " foot: magn. 200 diams.
f, " " anal marking: magn. 200 diams.
g, " " fringe: magn. 200 diams.

Art. XVII.—*On a Hymenopterous Insect parasitic on* Coccidæ.

By W. M. Maskell.

[*Read before the Philosophical Institute of Canterbury*, 4*th July*, 1878.]

Plate IX.

Some of the Coccidæ are much troubled by parasites. In this country I have not found this to be the case upon the naked-bodied species, *Lecanium*, etc. But some of the Diaspidæ, particularly *Mytilaspis pomorum*, have often in their shells minute white *Acari*; and as in these cases many of the enclosed eggs have been shrivelled or empty, I imagine that the *Acarus* may devour them.

The insect I am now describing attacks some of the indigenous test-bearing Coccidæ. When in June, 1877, I found my first specimens of *Ctenochiton perforatus*, I did not at first understand the nature of an object

HYMENOPTEROUS PARASITE ON COCCIDÆ.

which was frequently seen under the centre of the tests. This object, which is shown in the accompanying plate, fig. 1, I took to be the pupa of the male *Ctenochiton*.

Later on, in September, I found other pupæ in a more advanced stage, for I was able to detach them easily from the test of the scale. They now resembled the pupæ of *Eulophus nemati*, a common Hymenopterous insect. One of them is shown in my fig. 2, where it will be seen that the form of the head, with its bars or stripes, and the spurs on the end of the tibiæ, seem to refer the insect to the genera *Eulophus* or *Encyrtus*. In *Eulophus*, indeed, the antennæ are branched, but this could not be distinguished in the pupa stage.

In October, when searching for more specimens of *Ctenochiton* in order further to examine these pupæ, I came across a tree, one of the species of *Olearia*, on which I found numbers of them in another condition. The leaves of the tree had evidently been pierced by a leaf-mining insect, and were covered with the blisters formed by it. Some of these were closed, others open; in each of the closed ones I found the remains of the larva of the leaf-miner and the pupa of which I was in search. It was quite evident that it could not be the pupa of a male *Ctenochiton*. The blisters, I may mention, were on both sides of the leaves; but the orifice by which the insect escaped was always on the under side.

I was able to procure several specimens of this parasitic insect in the imago state.

According to Westwood, there are five families of parasitic Hymenoptera; but only one has all the characters of the insect I am describing. In the Evaniidæ the antennæ are straight and the wings are veined; in the Ichneumonidæ the same; in the Chalcididæ the pupa is naked; in the Chrysididæ the abdomen is oblong-ovate. There remains only the Proctotrupidæ, and to these I relegate my insect. Of the genera of this family *Diapria* approaches it most, by the form of the wings. The only other genus resembling it seems to be *Platygaster;* but, according to Westwood, the legs in this genus are "not saltatorial," whereas the fly before me can leap pretty actively. I may observe that Westwood states that the Coccidæ are much infested by Chalcidideous parasites, of a genus to which he gives the name "*Coccophagus*," and which, he says, is intermediate between *Encyrtus* and *Eulophus*. My insect cannot be this, for the antennæ have at least 12 joints, against 8 in *Coccophagus*, and the three terminal joints, although soldered together, do not form a club. Again, it cannot be *Encyrtus*, for there is no dilation of the tarsus; nor *Eulophus*, for the antennæ are not branched. And the thin covering of the pupa prevents it from entering the Chrysididæ.

I propose for this insect the name of *Diapria coccophaga.*

In colour the insect, to the naked eye, is black; under the microscope the vertex of the head is green, the eyes red, the thorax and abdomen brown with green streaks; the whole body diapered with spots. The posterior wings are furnished with two minute hooks. The antennæ are moniliform, with from 12 to 15 joints; elbowed at the third joint, the last three being soldered together. The head is transverse, the eyes faceted, the mandibles forcipate. The tarsus is five-jointed; the anterior pair of legs has a sharp curved spur with three points at the end of the tibia.

DESCRIPTION OF PLATE IX.

Fig. 1. Outline of test of *Ctenochiton perforatus*, with enclosed pupa of *Diapria.*

Fig. 2. Pupa of *Diapria coccophaga.*

Fig. 3.	1, Head of *D. coccophaga*, magnified		25	diams.
	2, Posterior wing,	,,	25	,,
	3, Antenna,	,,	55	,,
	4, Anterior leg, with spur,	,,	55	,,
	5, Mandible,	,,	200	,,
Fig. 4.	Female insect,	,,	10	,,
Fig. 5.	Ovipositor, retracted	,,	60	,,

Art. XVIII.—*New Zealand* Crustacea, *with Descriptions of New Species.* By George M. Thomson.

[*Read before the Otago Institute, 13th August*, 1878.]

Plate X.

The publication of a Catalogue of the New Zealand Crustacea by Mr. Miers, of the British Museum, under the auspices of the Government of this colony, fills up a wide gap in our records of local zoology, and enables others to work up the subject, on the spot, with a much greater degree of certainty. The catalogue enumerates altogether 140 species, of which no less than 62 sp. are *Brachyura* (Crabs); while of *Anomoura*, 13 sp.; *Macroura*, 18 sp.; *Stomapoda*, 2 sp.; *Isopoda*, 28 sp.; *Anisopoda*, 2 sp.; and *Amphipoda* 15 sp. are described. I now propose to add 22 species to the above, of which 19 are new to science. Of these, 2 species belong to *Macroura*, 6 to *Isopoda*, and 14 to *Amphipoda*. Type specimens of all of these are lodged in the Otago Museum.

I would here desire to express my thanks to Professor Hutton for the great assistance he has given me, and particularly for handing over for my inspection the collection of Crustacea in the Otago Museum, together with his own valuable notes and manuscript descriptions.

Decapoda macroura.

Sub-tribe Caridea. *Fam.* I. Crangonidae.

Crangon, *Fabricius.*

Internal antennæ dilated at the base, the peduncle short, and terminated by two filaments. External maxillipeds pediform, the terminal joint obtuse and flattened. Anterior legs sub-didactyle, stronger and thicker than the others; the hand flattened, the moveable finger inflexed upon the hand, and meeting a rudimentary thumb; second and third pairs very slender, the second didactyle; two last pairs shorter and thicker. Abdomen large and rounded.

1. *Crangon australis*, Hutton, MS. Cat. Fig. A.1.

Carapace with five longitudinal rows of spines, the outer with three from the base of the moveable plate, the next with five from the outer margin of the orbit, and the median with two. Moveable plate extending beyond the peduncle of the outer antennæ. Inner antennæ short, hardly passing the external maxillipeds. Anterior legs extending beyond the tip of the moveable plate; second pair about half the length of the first; the third much longer. Abdomen smooth, not keeled, suddenly contracted at the second and third segments from the end, posterior segment nearly cylindrical. Length 1½ inches. Common.

Cook Straits, Dunedin, and Stewart Island. (Allied to *C. spinosus*, of Britain).

Palæmon.

Sub-genus Leander, *Miers*' Cat., p. 85.

2. *Leander fluviatilis*, nov. sp. Fig. A.2.

Palæmon fluviatilis, Hutton, MS. Cat.

Beak narrow, slender, nearly straight, with from nine to fifteen teeth on the upper margin, which are more or less separated into three groups, the posterior of which consists of two, or rarely three, situated behind the orbit; the middle of four to six, in front of the orbit; and the anterior of three to six, much smaller and situated near the apex; four to six teeth on the lower margin. Anterior margin of carapace with one spine, and another over the inner angle of the orbit. Anterior feet short, but rather stout, reaching to the end of the peduncle of the outer antennæ; second pair very slender, longer, but not reaching to the tip of the moveable plate. Length 1½ inch.

Waikato River (Professor F. W. Hutton); Taieri River, and lagoons in Taieri plain.

Edriophthalmata.

Tribe I.—Isopoda.

Sub-tribe I. Idoteidea. *Genus* Idotea.

Idotea affinis, Miers' Cat., p. 93.

In the description given of this species the flagellum of the antennæ is said to be about 20-jointed, and the length 1¾ inch. The species is said also to "vary slightly in the number of the joints of the external antennæ."

In a great number examined by me, I found the length to vary from 1 inch to over 2½ inches, and the number of joints in the flagellum from sixteen up to thirty-two.

Sub-tribe II. Oniscoidea.

Fam. II. Oniscidæ. Miers' Cat., p. 98.

Sub-Fam. I. Oniscinæ. *Genus* Oniscus.

3. *Oniscus punctatus*, nov. sp. Fig. A.3.

Body rather convex, oval, minutely granulated over the entire surface. Head short and broad; eyes small, round and black. Antennæ finely hirsute, fifth joint the longest, equalling the last three. First segment of thorax wider than those succeeding; last segment produced acutely backwards. Abdomen not much narrower than thorax, but falling away rather abruptly; two anterior segments narrower than the others, and not produced into exserted lateral angles; three succeeding segments subequal, with their latero-posterior margins acutely produced; last segment short and rounded. Caudal stylets short, external branch the longest, narrow-cylindrical, minutely hirsute, with two or three short setæ at the extremities.

Colour light brown, with darker markings. Length ·3 inch.

Dunedin.

Sub-Fam. III. Ligiinæ.

Genus Ligia, *Miers'* Cat., p. 103.

4. *Ligia quadrata*, Hutton, MS. Cat. Fig. A.4.

Oval, sub-depressed, with minute granulations on the back, but free from hairs. Three posterior segments of thorax acutely prolonged backwards on either side. Abdomen considerably narrower than thorax, last segment sub-quadrate, the angles hardly projecting. Outer antennæ two-thirds the length of the animal, fourth and fifth joints much the longest; flagellum from 15-to 23-jointed, minutely setose. Base of caudal stylets about half as long as abdomen; rami slightly unequal, shorter branch with a long slender seta, which reaches beyond the extremity of the longer branch. Colour yellowish-olivaceous closely speckled with black. Length ·5 inch.

Dunedin.

This species lives among loose stones on the beach, and runs with great rapidity.

Sub-tribe III. Cymothoidea.

Fam. I. Cymothoidæ.

Genus Ceratothoa, *Miers'* Cat., p. 104.

5. *Ceratothoa trigonocephala.*

Cymothoa trigonocephala, M. Edw. Hist. Nat. Crust., iii., p. 272.

Head small, triangular, having the antero-lateral margins very concave above the antennæ, and the front narrow but obtuse, and projecting a little beyond the base of the inner antennæ. Eyes very distinct. Outer antennæ considerably longer than the inner. Anterior margin of the first thoracic segment produced a little at the corner upon the head so as to give rise to a tooth upon the median line; antero-lateral prolongations of medium size, narrowing in front, but rounded and not reaching to the base of the outer antennæ. First segment of the abdomen about a third less than the second, which exceeds on each side the margin of the last thoracic segment. Posterior margin of the fifth segment very sinuous, and presenting a deep, median indentation. Sixth segment large, but gradually narrowing from the base, rounded posteriorly, and not nearly so far extended as the terminal plates of the lateral appendages. Length 1·6 inch. (My specimens are about 1 inch long).

Dunedin.

This species is also found in the Australian and Chinese Seas.

Fam. III. Sphœromidæ. Miers' Cat., p. 109.

Genus Amphoroidea, *M. Edw.*, Hist. Nat. Crust., iii., p. 222.

Body convex, somewhat oval and flexible. Head quadrilateral, broader than long; eyes small, occupying the lateral margin; anterior margin of the head with five small teeth. Basal joint of inner antennæ very large, lamellate, quadrilateral, broader in front than behind, horizontal, and in contact with its fellow; second joint small, inserted at the side of the first, near its posterior angle; the rest almost moniliform. Outer antennæ inserted under the inner and directed forwards; the peduncle cylindrical, terminal joint longer than that of the inner antennæ. Abdomen broader than thorax; last joint large, scutiform and deeply excavated below.

6. *Amphoroidea falcifer*, Hutton, MS. Cat. Fig. A.5.

Smooth, sub-depressed, rounded on the back. Head broader than long, the anterior margin three-lobed, the middle one pointed and acute; lateral margins hollowed; posterior margin straight, sub-sinuated, produced posteriorly on either side into a truncated lobe. Basal joint of inner antennæ longer than broad, the anterior margin convex, the outer side straight, the posterior side bilobed, fitting into the lobes of the head. Outer antennæ reaching to the middle of the third thoracic segment. Last segment of the tail triangular, bidentate at the tip. Outer ramus of

appendages long, projecting considerably beyond the tail, falciform, acute, curved inwards; the inner much shorter, sub-rectangular, longer than broad, truncated at the apex. Claws short, subequal, hooked. Reddish brown. Length ·6 inch. Kaikoura Harbour and Stewart Island.

Note.—Since writing the foregoing description, I have seen, through favour of Dr. Haast, the Atlas of the Crustacea described by Dana in the Zoology of the U.S. Exploring Expedition. From the figures alone (not having been able to obtain a description), I think that this species may prove to be identical with *A. australiensis*, Dana.

Genus Cymodocea, *Miers'* Cat., p. 113.

Sub-genus Dynamena, *Leach*, Dict. Sc. Nat., t. 12., p. 343.

Terminal segment of the abdomen simply notched, but without a median lobe. Rami of caudal appendages lamellate, as in *Sphæroma.*

7. *Dynamena huttoni*, nov. sp. Fig. A.6.

Moderately convex, nearly smooth, marked with numerous minute granulations. Head small, twice as broad as long, with small obtuse frontal lobe. Segments of thorax subequal, the three last slightly produced backward at their infero-posterior margins, the last with a slightly rounded lobe, just overlapping the edge of the abdomen. First segment of abdomen with four lines of articulation, the last of which has a tooth on each side on its posterior margin. Last segment triangular, swollen above, ending in two short acute teeth, with a rounded sinus between them. Rami of caudal lamellæ equal, oval-oblong, obtuse. Orange-yellow colour. Length ·5 inch.

Dunedin.

I have named this species after Professor Hutton who collected it.

Genus Nesea, *M. Edw.*, Hist. Nat. Crust., iii., p. 216.

Body not very flexible, and incapable of being rolled into a ball. External ramus of the caudal lamellæ projecting, thick and rounded, incapable of being folded beneath the inner. Inner rami united to the inferior margin of the abdomen and carried transversely underneath it, so as to be easily mistaken for it.

8. *Nesea caniculata*, nov. sp. Fig. A.7.

Body very convex; roughly granulated, particularly towards the abdomen. Head prominently rounded. Eyes black, triangular, received into a deep indentation in the margin of the first thoracic segment; an intra-marginal groove extending between the eyes round the front of the head. Frontal lobe small, obtuse. Basal joint of inner antennæ large, and adhering rigidly to the head, second joint short and rounded, third slender. Outer

antennæ springing from underneath the base of the inner, half as long again, and slender. Segments of the thorax directed backwards at their postero-lateral margins; first segment broader than others; succeeding segments subequal, each with a flattened granulated ridge on its posterior margin, giving the back a transversely grooved appearance. First segment of abdomen produced posteriorly into a flattened truncate expansion, with a slight median indentation; last segment placed almost underneath the former, triangular in shape, with a pyramidal tubercle on each side, its apex united to the internal rami of the caudal lamellæ. External rami thick, angular, and two-jointed. Legs fringed on their inferior margins with short, thick hair. Colour dark brown. Length ·6 inch.

Dunedin.

Collected by Prof. Hutton.

Tribe III.—Amphipoda.

Division Normalia. *Family I.* Orchestidæ.

Talitrus? novæ-zealandiæ, Dana, (*Orchestoidea? novi-zealandiæ*).

This species is certainly the female of *Talorchestia quoyana*, and therefore ought to disappear from the catalogue. I have repeatedly found the two together, and in fact have seldom collected the one without the other. The males of the *Talitrus*, and the females of the *Talorchestia*, have never yet been described as such.

Genus Nicea.

Nicea, Nicolet, Gay's Chili, Vol. III., p. 237. 1849.

Galanthis, Spence Bate, Ann. Nat. Hist. 1857; and Cat. Amphip. Crust. Brit. Mus., p. 51. 1862.

This genus is defined as follows:—"Superior and inferior antennæ subequal, scarcely longer than the cephalon. The rest of the animal generally resembling *Allorchestes*, except the telson, which is deeply cleft."

It in reality includes all those Crustaceans which would range under *Allorchestes*, but for the cleft telson.

9. *Nicea novæ-zealandiæ*, nov. sp. Fig. B.1.

Eyes reniform. Inferior antennæ about one-fourth as long as body; flagellum slightly longer than base, with 13 or 14 articulations, which are minutely setose. Superior antennæ reaching to middle of flagellum of inferior; flagellum 14-jointed. Gnathopoda of first pair small; carpus produced inferiorly to a rounded lobe, furnished with a bundle of setæ; propodos sub-quadrate, inferior margin excavate about the middle and furnished with a bunch of setæ, palm transverse, defined by two stout spines, setose; a bunch of setæ at the articulation of the dactylos. Propodos of second gnathopoda large, ovate (almost pyriform) in male, palm very oblique, occupying nearly all the under surface, furnished with a double row of stiff setæ, and defined by two stout spines; dactylos long, slender,

arcuate. Same organ smaller in female, with the palm more transverse, and dactylos relatively shorter. First, second and third pairs of pereiopoda subequal; fourth and fifth longer; all with crests of short setæ at the joints. Telson deeply cleft, smooth. Colour yellowish, marbled with red. Length ·5 inch.

Rock pools at Taiaroa Head (Otago Harbour).

10. *Nicea fimbriata*, nov. sp. Fig. B.2.

Eyes round. Inferior antennæ about one-third as long as body; peduncle more than half as long as flagellum, penultimate joint crowned with a ring of short setæ, ultimate with a dense fringe of long, slender hairs on its inferior margin; flagellum from 17–22-jointed, each articulation with a dense bunch of long hairs on its inferior margin, diminishing towards the extremity. Superior antennæ half as long as inferior; flagellum 13–15-jointed, slender, minutely setose. First pair of gnathopoda with the carpus dilated; propodos broadly oblong, the palm very oblique, furnished with numerous setæ, and defined by two stout teeth. Gnathopoda of second pair large; propodos ovate, tapering to the extremity, lower margin densly fringed with long hairs, an excavation marking the very oblique and not well-defined palm. Pereiopoda subequal, second and third pairs rather the shortest. Telson cleft almost to the base, minutely tuberculated. Colour pale yellow. Length ·8 inch.

Dunedin.

11. *Nicea rubra*, nov. sp. Fig. B.3.

Eyes round. Inferior antennæ half as long as body; flagellum four times as long as peduncle, with over fifty articulations, sparingly and minutely setose. Superior antennæ nearly half as long as inferior; flagellum 18-jointed, joints slender, with their apices expanded, minutely setose. Gnathopoda of first pair with the carpus rounded; propodos oblong-quadrate, setose on the inferior margin, palm extending along half its length, obliquely transverse, defined by two teeth, and furnished with two rows of setæ. Gnathopoda of second pair with the propodos ovate, palm extending obliquely along half of its inferior margin, furnished with two rows of stout setæ, but without any defining spines; dactylos long and curved, with two tubercles at the joint. Fourth and fifth pairs of pereiopoda longer than those preceding. Telson deeply divided into two acute, smooth lobes. Colour pink. Length ·4 inch.

Dunedin.

Fam. II. Gammaridæ.

Genus Lysianassa, *Edwards*, Hist. Nat. Crust., iii, p. 20; *Dana*, U.S. Explor. Exped., p. 908; *Spence Bate*, Brit. Mus. Cat. Amphip., p. 64.

Superior antennæ pyriform, very short, stouter than the inferior, and furnished with a secondary appendage. Mandibles having an appendage;

the incisive edge not furnished with teeth; armed upon the anterior margin with a stout tubercle; secondary or moveable plate wanting. Maxillipeds with large squamiform processes attached to the third and fourth joints. First pair of gnathopoda not subchelate. The second pair subchelate, imperfectly developed, long, and membranous. Ischium and carpus long. Dactylos rudimentary. Coxæ of the gnathopoda and the two anterior pairs of pereiopoda deeper than their respective segments of the pereion; those of the second pair of pereiopoda produced inferiorly and posteriorly. Coxæ of the fourth pair much shorter than the third. Pereiopoda subequal. Posterior pair of pleopoda double-branched. Telson single, squamiform, entire.

12. *Lysianassa kröyeri*, Spence Bate, Brit. Mus. Cat. Amphip., p. 65.

Ephippiphora kröyeri, White, Ann. and Mag. Nat. Hist., ser. 2, vol. i., p. 226, 1848; and Zool. Erebus and Terror, pl. 5.

Animal not much compressed, smoothly arcuate; a dorsal sinus in the fourth segment of the pleon. Eyes reniform. Superior antennæ having the first joint of the peduncle reaching scarcely beyond the ocular process of the cephalon, the second and third joints very short; the flagellum not longer than the peduncle. Inferior antennæ three times as long as the superior, the peduncle not extending beyond the peduncle of the superior flagellum. First pair of gnathopoda having the propodos nearly three times as long as the carpus, and armed upon the under side with a strong curved spine near the base of the dactylos. Second pair of gnathopoda having the propodos a little shorter than the carpus, and both inferiorly covered with minute denticles; the propodos furnished upon the superior margin with tufts of long hair, serrated on both margins; palm short, inferior angle produced into a tubercle; dactylos not so long as the palm. Coxæ of the second pair of pereiopoda having the lower half of the posterior margin greatly produced. Posterior pair of pleopoda having the rami much longer than the basal articulation.

Dunedin.

This species was originally described from Tasmania, where it was obtained by Sir J. C. Ross. Its length is stated at 1 inch, but none of the specimens examined by me exceeded ·3 inch.

Genus Dexamine, *Leach*, Edin. Encyc. vii., p. 433; *Sp. Bate*, Brit. Mus. Cat. Amphip. Crust., p. 130.

Antennæ long, subequal, slender; superior not appendiculated; peduncle consisting of only two joints, the third not being distinguishable from the first of the flagellum. Mandibles without an appendage. Gnathopoda subequal, feeble, subchelate. Coxæ of the third pair of pereiopoda about half as deep as the preceding; dactyla of all the pereiopoda generally

directed posteriorly. Posterior pair of pleopoda biramous. Telson simple, divided, squamiform.

13. *Dexamine pacifica*, nov. sp. Fig. B.4.

Cephalon without a rostrum, but produced into an acute tooth between the bases of the antennæ. Pereion smooth; segments of pleon dorsally and posteriorly three-spined, and with the inferior margin produced posteriorly into an acute tooth. Eyes ovate-reniform. Superior antennæ about as long as the body; basal joint stout, with a spine at its lower anterior margin; second joint about twice as long; flagellum 40-50-jointed. Inferior antennæ about two-thirds as long as superior, slender; basal joint very short; second joint as long as corresponding joint of upper antennæ; ultimate joint of peduncle just half as long; flagellum about 25–30-jointed. Gnathopoda of first pair larger than second, with the inferior margin of the carpus and propodos crenulated and hairy; palm oblique, dactylos nearly straight. Second gnathopoda similarly toothed and hairy; propodos shorter, dilated, with two spines at the base of the palm; dactylos curved. Pereiopoda slender, thickly setose, all having the dactylos directed posteriorly, except the last pair, which also are much the longest. Penultimate pair of pleopoda reaching to extremity of ultimate; antepenultimate much shorter. Telson bifid, apex of each division with two or three small teeth and a few short hairs. Length ·25 inch. (No locality).

Genus Atylus, *Leach*, Zool. Miscel., ii., pl. 69; *Edwards*, Hist. des Crust., iii., p. 67; *S. Bate*, Brit. Mus. Cat. Amphip. Crust., p. 133.

Iphimedia, *Dana*, U. S. Explor. Exped., p. 926.

Animal compressed. Antennæ subequal; superior without a secondary appendage. Mandibles with an appendage. Maxillipeds unguiculate, having a squamiform plate developed from the bases and ischium. Gnathopoda subchelate. Pereiopoda subequal. Posterior pleopoda biramous. Telson single, squamiform, divided.

Differs from *Dexamine* in having the third joint of the peduncle of the upper antennæ distinguishable from the flagellum, and in having an appendage to the mandibles.

14. *Atylus dania*, nov. sp. Fig. C.1.

Cephalon produced into a short rostrum. Segments of the pleon slightly elevated posteriorly, fourth segment with a deep dorsal sinus, none prolonged into teeth; margins smooth. Eyes large, round, black. Superior antennæ about a third shorter than the inferior; joints of the peduncle short, subequal, produced into three teeth on the lower margin; flagellum with over 25 articulations, which are broader than long, every third or fourth joint produced on its inferior margin into a tubercle, bearing several long cilia and a crown of short hairs. Inferior antennæ half as long as

body, also with fascicles of hairs on the under surface of the peduncle; flagellum with between 40 and 50 articulations. Gnathopoda rather small, subequal; carpus somewhat produced on its inferior surface; propodos ovate, with several transverse rows of spines on the infero-posterior margin; palm imperfectly defined; dactylos slender, smooth. Three posterior pairs of pereiopoda having the basa increasing in width. Antepenultimate pair of pleopoda reaching to the extremity of the penultimate, smooth; penultimate pair with a few spines; ultimate pair with the rami about twice as long as the peduncle, thickly studded with short spines and fringed with long cilia. Telson divided to nearly half its length, with a minute spine somewhat remote from the apex at each side. Length ·3 inch. Semi-transparent in colour, with dark blueish spots.

Rock pools, Dunedin.

(Named after Prof. Dana).

Genus Pherusa, *Leach*, Edin. Encyc., vii., p. 432, etc.; *Spence Bate*, Brit. Mus. Cat. Amphip. Crust., p. 143.

Antennæ subequal; superior without a secondary appendage. Mandibles with an appendage. Maxillipeds unguiculate, and furnished with a squamiform plate. Gnathopoda subchelate. Telson single, squamiform, entire.

15. *Pherusa novæ-zealandiæ*, nov. sp. Fig. C.2.

Cephalon produced into a small, acute rostrum between the bases of the superior antennæ. Eyes oblong-reniform. Two posterior segments of the pereion and two anterior segments of the pleon produced dorsally into two teeth. Antennæ about as long as body. Peduncle of the superior pair about one-fifth as long as the slender flagellum; basal joint very short, buried in front of the cephalon, second joint stout. Gnathopoda small. First pair very long and slender; carpus and propodos subequal, linear; dactylos minute, transverse. Second pair short; propodos expanded above, palm obliquely transverse, defined by a tooth. Three last pairs of pereiopoda much longer than preceding; their coxæ with comblike teeth on their posterior margins. Third segment of pleon with the sides produced posteriorly, and ending abruptly in a serrated margin (almost smooth in young specimens). Posterior pair of pleopoda reaching to the extremity of the penultimate pair. Length about ·3 inch.

Dunedin.

Genus Calliope, *Leach*, MS. Brit. Mus.; *Spence Bate*, Brit. Mus. Cat. Amphip. Crust., p. 148.

Superior antennæ without a secondary appendage. Mandibles furnished with an appendage. Gnathopoda having the propoda in the second or both pairs largely developed, and the carpi inferiorly produced. Telson not divided.

16. *Calliope didactyla*, nov. sp. Fig. C.3.

Cephalon without a rostrum; the whole back of the animal smooth. Superior antennæ two-thirds as long as inferior; joints of the peduncle subequal; flagellum about 17-jointed, each articulation with an auditory cilium and a few short hairs. Lower antennæ with the peduncle extending to middle of flagellum of upper; basal joint very short, next two subequal; flagellum about 15-jointed. First pair of gnathopoda small; carpus produced posteriorly into a large acute projection; propodos subquadrate, bulged posteriorly, with an ill-defined palm, and bearing a *double-clawed dactylos*. Second pair of gnathopoda large, carpus triangular, acute, its inferior portion separated into a narrow, arcuate projection, ciliated on its lower margin, and curving slightly round the base of the propodos; propodos dilated, ovate, with an oblique and tolerably well-defined palm, marked by a double row of long teeth, and its base by two stout spines; dactylos arcuate, with a double row of very short, sharp, equi-distant teeth. First and second pairs of pereiopoda slender; other pairs somewhat larger. Penultimate pair of pleopoda reaching slightly beyond the ultimate; rami of all the pleopoda spinose. Telson foliaceous, truncate, slightly produced at the apex.

Female. Both pairs of ngathopoda small, subequal; carpus developed posteriorly into an obtuse projection, which has a small fringe at its apex; propodos with a transverse palm; dactylos single and slightly toothed.

Whole body of a rich brown colour, with greenish grey eyes. Length, about ·3 inch.

Among kelp washed upon the beach at Taieri mouth.

(When preserved in spirits the body becomes yellowish-white in colour, and the eyes jet black.)

17. *Calliope fluviatilis*, nov. sp. Fig. C.4.

Cephalon without a rostrum. Body slender, compressed. Eyes large, black, rounded. Upper antennæ about one-fourth shorter than lower; peduncle—with apparently only two joints—not reaching to extremity of penultimate joint of peduncle of lower. First pair of gnathopoda rather smaller than second; carpus triangular, developed posteriorly into a rounded lobe, ciliated at the extremity; propodos oval, palm transverse, dactylos acute, nearly straight, half as long as propodos. Second pair of gnathopoda apparently reversed; carpus produced anteriorly (posteriorly) into a narrow obtuse lobe. Last pair of pereiopoda much longer than preceding. Pleopoda long and slender; antepenultimate and penultimate pairs reaching to extremity of the ultimate. Telson squamiform, rounded, entire. Colour greyish, more or less marked with dark spots, and frequently covered with circular, wart-like markings. Length ·2 inch.

Common in fresh water round Dunedin.

Paramoera tenuicornis, Miers, Cat. N. Z. Crust., p. 127. Fig. C.5.

This species, of which I have examined perfect specimens, must be replaced in the genus proposed by its original describer Dana, viz., *Melita*. It differs from *Paramoera* in having the superior antennæ furnished with an appendage, and from *Moera*—in which it is placed by Spence Bate in the British Museum Catalogue—in having the posterior pair of pleopoda very unequal, with the inner ramus quite rudimentary, and not subfoliaceous.

There are several points in connection with the specific description which require amending. Thus the flagellum of the *inferior antennæ only* is terete, that of the upper pair having the joints wider at the apex than at the base; the appendage to this pair consists of 4 joints, and springs from the apex of the last joint of the peduncle. The fifth segment of the pleon is furnished on the dorsal posterior margin with a crest of spinose setæ. The antepenultimate and penultimate pairs of pleopoda only reach to the extremity of the peduncle of the ultimate. The external ramus of the last pair is very long, while the internal is a mere rudiment.

The specimens examined by me were taken in the Taieri River in fresh water, but they had probably come up with the tide, which is felt 15 miles from the mouth.

Genus Gammarus, *Fabricius*, Ent. Syst. ii., p. 514.; *Spence Bate*, Brit. Mus. Cat. Amphip. Crust., p. 203.

(The generic characters are taken from the latter authority quoted).

Slender, laterally compressed. Cephalon not produced into a rostrum. Perœion and pleon subequal in length. Three posterior segments of the pleon having each two or more fasciculi of short stiff spines. Eyes reniform, oval or linear. Antennæ long, slender, filiform, having the peduncle subequal with the peduncle of the inferior, and carrying a secondary appendage. Mandibles having an appendage. Maxillipeds having a squamiform plate, arising from the basos and ischium. Gnathopoda subequal, not largely developed. Pereiopoda subequal; coxæ of the three posterior pairs much shorter than those of the anterior. Posterior pair of pleopoda biramous. Telson double.

18. *Gammarus barbimanus*, nov. sp. Fig. D.1.

Segments of the body smooth. Eyes small, oblong, with dark coloured blotches between and posterior to them. Superior antennæ with the peduncle longer than the flagellum; basal joint with a spine on its inferior margin; appendage 5-jointed, less than half as long as the flagellum, which is about 10-jointed. Inferior antennæ somewhat shorter than superior, but stouter; peduncle extending to the extremity of the peduncle of the upper antennæ; flagellum stout, short, about 6-jointed. Maxillipeds with a dense

fringe of hairs on the lower surface. First pair of gnathopoda with carpus and propodos subequal, straight, and densely clothed with long, feathery hairs. Second pair with the carpus long, straight, and flat on the under surface, which is fringed with a double row of similar plumose hairs; propodos tapering and hairy; dactylos minute. Fourth and fifth pairs of pereiopoda longer and stouter than preceding pairs. Antepenultimate and penultimate pairs of pleopoda reaching to extremity of ultimate; all three pairs fringed with short spines. Telson short, reaching to extremity of peduncle of ultimate pleopoda, and furnished with a few short spines.

(No locality). Length ·3 inch.

Sub-tribe. Hyperidea.

Fam. I. Hyperidæ, *Spence Bate*, Brit. Mus. Cat. Amphip. Crust. p. 287.

Superior antennæ, with a peduncle of three joints, and a variable flagellum. Inferior antennæ, with a five-jointed (?) peduncle, and multi-articulate flagellum. Gnathopoda more or less complexly subchelate. Four anterior pairs of pereiopoda subequal, normal. Three anterior pairs of pleopoda normal; three posterior pairs, broad, flat, and biramous. Integument thin and free from hairs.

Genus Themisto, *Guérin-Méneville*, Mém. de la Soc. d'Hist. Nat. de Paris, iv., 1828; *Edwards*, Hist. des Crust., iii., p. 84; *Spence Bate*, Brit. Mus. Cat. Amphip. Crust. p. 311.

Cephalon transversely ovate. Pereion not largely distended. Pleon slender. Eyes occupying the entire cephalon, dorsally separated. Antennæ subequal, as long as the cephalon is deep; superior pair having the flagellum not articulated; inferior pair having the flagellum more or less articulated. Mandible having an appendage. First pair of gnathopoda short, tolerably robust; carpus not having the anterior margin inferiorly produced; second pair having the carpus on the inferior angle anteriorly produced. First pair of pereiopoda having the carpus dilated; propodos narrow, and capable of being inflected against the carpus; second pair like the first; third pair twice the length of the second; carpus very long; propodos longer than the carpus, fringed along the anterior margin with a comb-like series of teeth, and capable of impinging against the anterior margin of the carpus; fourth and fifth pairs subequal, of the same form as the third, but not more than half the length. Three posterior pairs of pleopoda subequal, the last being the longest; rami double, lanceolate. Telson small, squamose.

The above description is taken from Spence Bate's catalogue, and from the examination of a great number of specimens I can vouch for its correctness as far as females are concerned, from which indeed all the descriptions appear to have been taken. The males, however, differ in the

superior antennæ in a very striking manner, this being furnished in this sex with a multi-articulate flagellum of about 13 joints.

19. *Themisto antarctica*, Dana, U.S. Explor. Exped., p. 1005, pl. 69, fig. 1; Spence Bate, Brit. Mus. Cat. Amphip. Crust. p. 312.

Male. Eyes reddish. Superior antennæ with the peduncle 3-jointed; second joint extremely short; third long, slightly arcuate, tapering to the extremity, fringed on the lower margin with fine comb-like teeth and numerous hairs; flagellum of twelve or thirteen articulations, which lengthen towards the extremity, Inferior antennæ half as long again as the superior; peduncle 3-jointed; flagellum of seventeen slender articulations, basal one long, those succeeding short, but lengthening to the extremity. First pair of gnathopoda with a broad carpus, fringed posteriorly with numerous hairs; propodos about half as broad as carpus, tapering to the extremity, furnished on the anterior margin with a row of stiff cilia. Second pair of gnathopoda having the carpus infero-anteriorly produced nearly to the extremity of the propodos, with the inferior margin furnished with a few hairs; propodos slightly tapering, and furnished with a few hairs on the superior margin; dactylos short and straight. First pair of pereiopoda twice as long as the gnathopoda, having the meros short, expanded below; carpus stout, with a few hairs on the infero-posterior margin; propodos as long as carpus, slender, arcuate, inner margin double, the most prominent, and fringed with closely-set, straight, minute cilia, the outer with long straight hairs; dactylos subulate. Second pair of pereiopoda resembling the first, but having the carpus slightly larger. Third pair of pereiopoda nearly twice as long as first two; basos stout; meros short; carpus long, and furnished on its anterior margin with equi-distant comb-like teeth, and minute, close-set thick cilia between; propodos long, slightly curved and slender, similarly furnished on its anterior margin; dactylos short, slender, sharp, and slightly curved. Fourth pair of pereiopoda about half the length of the third, and resembling it in form: fifth pair like the fourth, but not armed with fine teeth along the anterior margin of the propodos. Ultimate pair of pleopoda having the peduncle more than four times the length of the telson, and the rami half as long as the peduncle, with the margins scarcely serrated; penultimate pair reaching a little beyond the extremity of the peduncle of the ultimate; antepenultimate reaching a little further than the extremity of the penultimate. Telson lanceolate.

Female. Superior antennæ with the basal joint of the peduncle nearly covering the second; terminal joint (flagellum, according to Sp. Bate) elongated, tapering to the point, which is curved like a hook, furnished on its lower margin with a row of comb-like teeth. Other characters as above.

Length about ¾ of an inch.

The young, taken from the incubatory pouch of the female, differ somewhat from the adult. The back is smooth and rounded, whereas in the adult it is sharply keeled, and the segments of the pereion are produced posteriorly into teeth. The pereion is very broad and expanded. Antennæ subequal; superior stout and conical, three-jointed, terminal joint with a few short setæ at the extremity and two longer ones projecting at right angles from near the middle of the inferior margin ; inferior pair somewhat more slender, and with very minute setæ. Some of the appendages also are either wanting or are not fully developed, probably the first or second pair of gnathopoda. Pleopoda normally developed.

These minute creatures approach in form and general appearance to *Hyperia cyanea* much more than *Themisto*. Every adult female had several of them in the incubatory pouch under the pereion.

Frequently washed up on Ocean Beach, Dunedin.

Fam. III. Platyscelidæ.

Cephalon round. Eyes large. Antennæ attached to the inferior surface. Epistoma proboscidiform; oral appendages rudimentary. Gnathopoda complexly subchelate. First two pairs of pereiopoda simple ; two succeeding pairs having the basa largely dilated ; fifth pair imperfectly developed. Posterior pleopoda foliaceous.

Genus Platyscelus, *Spence Bate,*
Brit. Mus. Cat. Amphip. Crust., p. 329.

Cephalon transversely ovate. Pereion distended ; first segment narrower than the cephalon. Pleon much narrower than the pereion, having the fourth and fifth segments coalescing, the fifth and sixth pairs of pleopoda being attached to the posterior margin ; sixth segment and telson fused together, the posterior pair of pleopoda being attached to the under surface near the middle of the segment. Superior antennæ short, consisting of a peduncle and a flagellum. Inferior antennæ not longer than the cephalon, consisting of four joints, concealed beneath the cephalon, not folded. Mandibles without an appendage. Third pair of pereiopoda having the basos largely dilated, and the remaining joints shorter than the basos ; fourth pair having the basos twice as large as the third, the remaining joints not half so long as the basos ; fifth pair membranous, a small tubercle representing the remaining joints. Three posterior pairs of pleopoda biramous, foliaceous, submembranous. Telson obtusely triangular.

20. *Platyscelus intermedius,* nov. sp. Fig. D.4.

Cephalon rounded in front. First two segments of pereion very narrow; succeeding broader, subequal. Eyes very large, occupying nearly the whole cephalon, with a large triangular red pigment spot on the outside of each. Epistoma triangular. Antennæ placed quite underneath the epistome.

Superior pair consisting of a stout peduncle, bearing a crown of cilia and a small tuberculate appendage, with a flagellum of two long slender articulations. Inferior antennæ four-jointed; first three joints subequal, with numerous cilia; fourth joint very short and furnished with a few long hairs at its extremity. First pair of gnathopoda with the carpus antero-inferiorly produced to an acute point almost to the extremity of the propodos, serrated on both margins, with numerous slender spines surrounding it near the base of the propodos; propodos narrow-oblong, serrated on both margins, with a small dactylos which antagonises with the extremity of the carpus. Second pair of gnathopoda similar to first, but rather larger, and with the carpus produced slightly beyond the extremity of the propodos. First two pairs of pereiopoda with the basos somewhat dilated; meros, carpus and propodos diminishing uniformly in size and quite smooth; dactylos very small, acute. Third pair with the margin of the basos quite smooth, and the distal extremity sub-acute; ischium articulating subapically within the posterior margin; remaining joints about half as long as the basos; meros and carpus quite smooth; propodos slender, slightly longer than the preceding joints, and serrated on the posterior margin only. Fourth pair of pereiopoda with the basos posteriorly arcuate and anteriorly excavate, rounded at the extremity; ischium articulating within the posterior margin near the centre; remaining joints about one-third as long as basos; meros very small; carpus long; propodos half its length, both serrated on the posterior margins; dactylos long, nearly straight, sub-acute. Fifth pair of pereiopoda membranous; basos curved forward nearly to a right angle; remaining joints represented by a small tubercle. Three last pairs of pleopoda foliaceous; ante-penultimate pair having a short peduncle, the rami somewhat unequal, margins smooth; penultimate pair with a long peduncle and rami subequal, outer ramus finely serrate on its outer margin; ultimate pair with the peduncle rather short and rami very unequal; external ramus minute, lanceolate, with smooth margins; internal ramus oblong, oblique, finely serrate on the distal half of both margins. Telson triangular, obtusely pointed.

Colour yellow, nearly transparent, with small red spots. Length ·5 inch. Can roll itself almost into a ball.

Washed up on the Ocean Beach at Dunedin.

I have named this species as above, from the fact that it is almost intermediate between the only two species hitherto described—*P. rissoinæ*, Bate, and *P. serratus*, Bate.

Spence Bate remarks of this genus:—"It appears to me to be not improbable that *Platyscelus* may prove to be the female of *Typhis (Thyropus)*, from which it differs, only in the form of the superior and length of the inferior antennæ."

Group Aberrantia.

Coxæ of the pereiopoda not squamiformly developed, some, or all, being fused to their respective segments. One or more segments of the pleon absent.

Fam. Caprellidæ.

Pleon rudimentary. Oral appendages normally developed. Coxæ fused with the pereion. Branchial sacs attached to the first two or three segments of the pereion.

Genus I. Caprella, *Lamarck,* Syst. des. Anim. sans Vert., p. 165; *Edwards,* Hist. Nat. Crust., iii., p. 105; *Spence Bate,* Brit. Mus. Cat. Amphip. Crust., p. 353.

Body cylindrical. Cephalon and first segment of the pereion confluent. Pleon rudimentary. Gnathopoda subchelate. First two pairs of pereiopoda represented by the branchiæ attached to their respective segments only; three posterior pairs of pereiopoda subequal. First and second pairs of pleopoda rudimentary in the male; the rest obsolete.

21. *Caprella caudata,* nov. sp. Fig. D.5.

Female. Body rather robust. Cephalon smooth, not toothed nor tuberculate, short; four succeeding segments of pereion subequal. Eyes round. Superior antennæ more than half as long as body; first joint of peduncle with an acute spine on the antero-superior margin; second joint longest; flagellum about 15-jointed (first few fused together), as long as peduncle, and spinose at the articulations. Inferior antennæ more than half as long as the superior; two basal joints short and smooth; the rest fringed on their lower margin with long hairs. Maxillipeds well developed, unguiculate, ciliate on the lower margin, with the carpus distended. First pair of gnathopoda small and fringed with hairs; carpus with a deep transverse incision; propodos ovate, dactylos long and slender. Second pair of gnathopoda large; propodos narrow-ovate, with the palm extending along the greater part of the lower margin, with a large tooth surmounted by two spines to receive the point of the dactylos, and two smaller teeth nearer the hinge corresponding to two indentations in the dactylos; dactylos stout, curved. Branchiæ narrow-oblong. Ovigerous pouches nearly circular, thickly ciliated on their inner margins. Three last pairs of pereiopoda increasing in size posteriorly, similar in shape; in all the propodos is narrow, excavate along its anterior margin to receive the slender curved dactylos, point of impingement of which is marked by two serrated spines. First pair of pleopoda rudimentary, represented by minute tubercles. Pleon prolonged into a slender flat expansion.

Dunedin, in rock pools. Length ·4 inch.

Genus Caprellina, *nov. gen.*

Body cylindrical. Cephalon confluent with first segment of pereion. Pleon rudimentary. Gnathopoda sub-chelate; branchiæ attached to second pair. First two pairs of pereiopoda represented by the branchiæ attached to their respective segments; third pair feebly developed; two posterior pairs well developed, subequal. First and second pairs of pleopoda rudimentary in the male, rest obsolete.

This genus appears to be intermediate between *Cercops* and *Caprella*. From the former, it differs in not having the pleopoda developed, but agrees with it in having branchiæ attached to the second gnathopoda. In respect to this latter character it differs from its nearer ally *Caprella*, and also in having the third pair of pereiopoda feebly developed.

The genus contains only the following species:—

22. *Caprellina novæ-zealandiæ*, nov. sp. Fig. D.6.

Body slender. Second and third segments of pereion shorter than the three following; last segment very short. Superior antennæ nearly half as long as animal; basal joint of peduncle stout, two succeeding joints long and slender; flagellum setose, semi-articulate at the basal end, ending in about ten articulations. Inferior antennæ very short, reaching to middle of penultimate joint of peduncle of superior. First pair of gnathopoda with the propodos ovate, the palm extending along the inferior margin, fringed with cilia, and with two spines at the base; dactylos sparingly ciliated on inner margin. Second pair of gnathopoda much larger than first, and having the basos very long. Propodos long, narrow ovate, palm extending along half the inferior margin, hollowed out, and with two or three small spines at the denticulation which receives the point of the dactylos, and a tooth near the hinge; dactylos slender, arcuate. Third pair of pereiopoda very small, but with well-developed carpus, propodos and dactylos. Fourth and fifth pairs of pereiopoda long; propoda well-developed, narrow-ovate, with slightly excavated palms fringed with strong spines; dactylos minutely ciliate on inner margin. Two pairs of pleopoda present, one-jointed, filiform, fringed with minute, comb-like cilia. Colour pale red, with dark spots and markings. Length ·8 inch.

Dunedin, in rock pools.

DESCRIPTION OF PLATE X.

Fig. A (all enlarged)—

1. *Crangon australis*: (*a*), head viewed from above, magn. 2; (*b*), leg of first pair, magn. 6; (*c*), leg of second pair, magn. 3.
2. *Leander fluviatilis*, magn. 1½: (*a*), rostrum, magn. 4.
3. *Oniscus punctatus*, magn. 2: (*a*), caudal stylet, magn. 10.
4. *Ligia quadrata*, magn. 1½: (*a*), tail and caudal stylets, magn. 4.

5. *Amphoroidea falcifer*, magn. 2.
6. *Dynamena huttoni*, magn. 2.
7. *Nesea caniculata*, magn. 1½ : (*a*), abdomen viewed from below, magn. 2½.

Fig. B (all enlarged)—

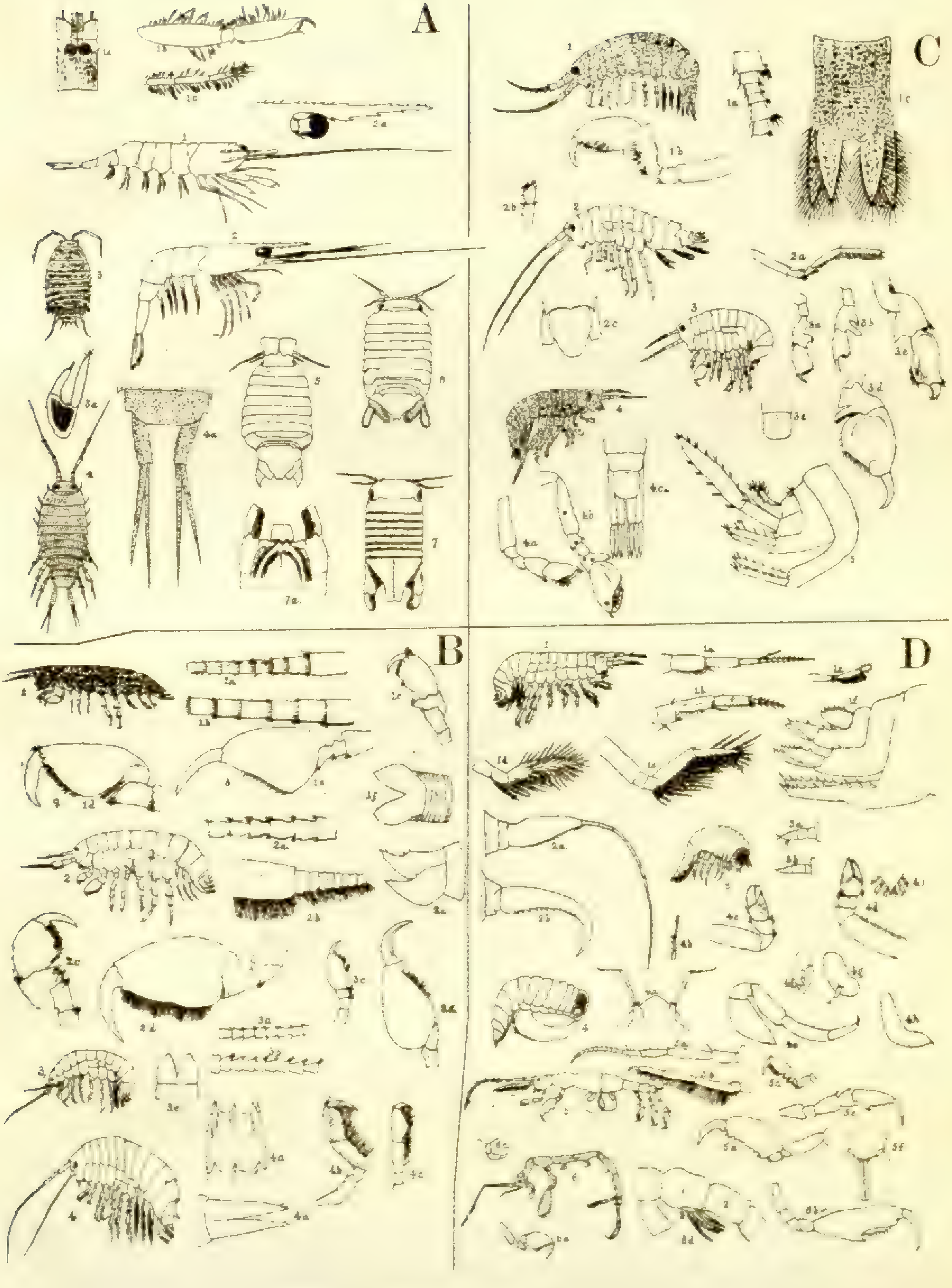
1. *Nicea novæ-zealandiæ*, magn. 2 : (*a*), superior antennæ, magn. 22 ; (*b*), inferior antennæ, magn. 22 ; (*c*), first gnathopod, magn. 11 ; (*d*), second gnathopod (female), magn. 11 ; (*e*), second gnathopod (male), magn. 11 ; (*f*), telson, magn. 11.
2. *Nicea fimbriata*, magn. 2 : (*a*), superior antennæ, magn. 22 ; (*b*), inferior antennæ, magn. 22 ; (*c*), first gnathopod, magn. 11 ; (*d*), second gnathopod, magn. 11 ; (*e*), telson, magn. 11.
3. *Nicea rubra*, magn. 2 : (*a*), superior antennæ, magn. 22 ; (*b*), inferior antennæ, magn. 22 ; (*c*), first gnathopod, magn. 11 ; (*d*), second gnathopod, magn. 11 ; (*e*), telson, magn. 11.
4. *Dexamine pacifica*, magn. 4 : (*a*), segment of pleon viewed dorsally, magn. 11 ; (*b*), first gnathopod, magn. 11 ; (*c*), second gnathopod, magn. 11 ; (*d*), telson, magn. 22.

Fig. C (all enlarged)—

1. *Atylus danai*, magn. 3 : (*a*), portion of superior antennæ, magn. 22 ; (*b*), first gnathopod, magn. 22 ; (*c*), telson and posterior pleopoda, magn. 22.
2. *Pherusa novæ-zealandiæ*, magn. 3 : (*a*), first gnathopod, magn. 11 ; (*b*), second gnathopod, magn. 11 ; (*c*), telson, magn. 11.
3. *Calliope didactyla*, magn. 2½ : (*a*), first gnathopod (female), magn. 11 ; (*b*), second gnathopod (female), magn. 11 ; (*c*), first gnathopod (male), magn. 11 ; (*d*), second gnathopod (male), magn. 11 ; (*e*), telson, magn. 11.
4. *Calliope fluviatilis*, magn. 4 : (*a*), first gnathopod, magn. 11 ; (*b*), second gnathopod, magn. 11 ; (*c*), telson and pleopoda, magn. 11.
5. *Melita tenuicornis :* posterior segments of pleon, magn. 11.

Fig. D (all enlarged)—

1. *Gammarus barbimanus*, magn. 3 : (*a*), superior antennæ, magn. 11 ; (*b*), inferior antennæ, magn. 11 ; (*c*), maxillipeds, magn. 11 ; (*d*), first gnathopod, magn. 11 ; (*e*), second gnathopod, magn. 11 ; (*f*), telson and pleopoda, magn. 11.
2. *Themisto antarctica :* superior antennæ, magn. 11, (*a*) male, (*b*) female.
3. Young of *Themisto antarctica*, magn. 11 : (*a*), superior antennæ, magn. 37 ; (*b*), inferior antennæ, magn. 37.
4. *Platyscelus intermedius*, magn. 2 : (*a*), under-surface of epistome, with superior antennæ, magn. 7½ ; (*b*), inferior antennæ, magn. 7½ ; (*c*), first gnathopod, magn. 7½ ; (*d*), second gnathopod, magn. 7½ ; (*e*), first (and second) pereiopoda, magn. 7½ ; (*f*), third pereiopoda, magn. 1½ : (*g*), fourth pereiopoda, magn. 1½ ; (*h*), fifth pereiopoda, magn. 7½ ; (*i*), telson and pleopoda, magn. 2½.
5. *Caprella caudata*, magn. 4 : (*a*), superior antennæ, magn. 11 ; (*b*), inferior antennæ, magn. 11 ; (*c*), first gnathopod, magn. 11 ; (*d*), second gnathopod, magn. 11 ; (*e*), posterior pereiopoda, magn. 11 ; (*f*), pleon, magn. 20.
6. *Caprellina novæ-zealandiæ*, magn. 1½ : (*a*), first gnathopod, magn. 7½ ; (*b*), second gnathopod, magn. 7½ ; (*c*), third pereiopod, magn. 7½ ; (*d*), pleopoda (1, last segment of pereion ; 2, basos of posterior pereiopoda; 3, pleon), magn. 15.



CRUSTACEA

Art. XIX.—*Description of New Crustacean from the Auckland Islands.*
By George M. Thomson.

[Read before the Otago Institute, 10th September, 1878.]

Fam. Oniscidæ. *Sub-fam.* Scyphacinæ.

Genus Actæcia, *Dana*, U.S. Explor. Exped., XIV. Crust., p. ii., p. 734.

Antennæ very stout, not distinctly geniculate at the fifth joint; flagellum indistinctly 5–6-jointed, exclusive of the minute apical joint. Terminal joint of maxillipeds broad and serrately lobed. Feet of the seventh pair as long as the others.

After his description of *Scyphax ornatus*, Dana describes and figures a smaller specimen which was found at the same time and in the same locality, and which he suspects may be the young of that species. Besides many minor points of difference, however, it is quite distinct from the generic character of *Scyphax*, in possessing the seventh pair of legs of normal size. He remarks, that if this is a new species, it is also a distinct genus, and suggests that it may be named *Actæcia euchroa* as designated in his earlier MSS. The species found by Mr. Jennings on the Auckland Islands, being evidently an *Actæcia*, I have drawn up the above generic character. The genus therefore contains the following species:—

1. *Actæcia euchroa*, Dana.

Body elliptic, abdomen not abruptly narrower than thorax. Head short, transverse. Eyes rather large and prominent. Antennæ short, curving outwards, surface minutely spinulous. Last thoracic segment not shorter than the preceding. Abdomen filling the concavity below the last thoracic segment, and forming a semicircle beyond it. Third, fourth and fifth abdominal segments much produced backward on either side. Last segment smallest, not projecting between the stylets, which are placed close together. Large branch of stylets very short and obtuse; smaller branch quite slender and arising from a point far anterior to the base of the larger branch.

Surface of thorax and abdomen with a few very short scattered spinules. Length 2 lines.

Bay of Islands—Parua Harbour (Dana).

2. *Actæcia aucklandiæ*, nov. sp.

Body narrow-oblong, abdomen narrowing gradually from the thorax. Head triangular, widest in front; anterior margin nearly straight, rounded at the corners; eyes situated above the angular projections. Segments of thorax subequal, more or less acutely produced posteriorly. Two first segments of the abdomen partly covered by thorax; last segment (sixth) much narrower than preceding, broadly triangular, and with obtuse apex. Caudal stylets subequal, only about half as long as abdomen; inner rami placed

close together between the two external, completely exposed. Antennæ hirsute towards the extremity; basal joint short; fifth joint expanding posteriorly; flagellum short and thick, all the joints together not so long as preceding. Colour brown. Whole body more or less covered with minute granules.

In the female each segment of the body is furnished with a row of stout, obtuse spines, which are longest towards the side of the thorax. In the male the whole body is nearly smooth. Length ·8 to 1·2 inch.

Auckland Islands (Mr. Jennings).

Art. XX.—*Description of a New Species of Isopodous Crustacean* (Idotea).

By George M. Thomson.

(*Read before the Otago Institute, 26th November, 1878.*)

The animals forming the genus *Idotea* are readily distinguished from other Isopods by having the segments of the abdomen more or less coalescent, and fewer than the normal number, seven, and particularly in having the "terminal segment very large, its appendages greatly developed, covering the whole inferior surface of the abdomen, and closing like doors over the branchial appendages."

Of the three species described in Miers' Catalogue of N. Z. Crust., pp. 92, 93, the first, *I. argentea*, Dana, is a doubtful New Zealand species, having been obtained by Dana *near* New Zealand. It is found on the Australian Coasts, and also at Borneo, and is probably common in the West Pacific. The second species *I. affinis*, M. Edw., is common on our coasts, and seems to be the same as a species found on St. Paul's Island, and at the Cape. The third, *I. elongata*, Miers, has only been found hitherto at the Auckland Islands. The species which I now propose to add, is chiefly remarkable for its habitat, being the only species, as far as I can find out, occurring in fresh water. Numerous specimens were found by Prof. Hutton in the Tomahawk lagoon, near Dunedin. They were creeping about under stones, and appeared to be feeding on the ova of a fish, probably *Galaxias*, sp., which was found abundantly in the same locality. Whether they occur permanently in the fresh water, or only come up when a very high tide renders communication with the lagoon possible, I cannot say. The species is a distinct one, and has not hitherto been found on our coasts.

Genus Idotea, *Fabr.*

Idotea, Miers' Cat. N. Z. Crust., p. 91.

Idotea lacustris, nov. sp.

Body narrow-elliptical, little more than twice as long as broad. Front of head excavate, not toothed. First segment of thorax somewhat longer than those succeeding, which are subequal; epimeral pieces nearly square, the last three slightly produced posteriorly.

Abdomen 3-jointed, terminal joint (formed of three coalescent segments) hardly narrowing to the rounded extremity. Inner antennæ not half as long as base of the outer, 4-jointed, joints subequal. Outer antennæ one third as long as the body, flagellum 9–11-jointed, with a dense fringe of very short setæ on the outer margin. Colour dark gray, mottled with brown, with a darker median band extending from the head to near the extremity of the abdomen. Length ·6 inch.

In numerous females, an incubatory pouch extended along the whole under surface of the thorax. The young animals, taken out of this sac, have their bodies somewhat elongated in shape, with all the segments developed, and appendages present, but having the outer antennæ furnished with a flagellum of only one joint and a few short setæ.

Art. XXI.—*On the New Zealand* Entomostraca. By George M. Thomson.

[*Read before the Otago Institute, 26th November*, 1878.]

Plate XI.

The study of the lower orders of Crustaceans is, as a rule, confined to a few specialists, hence it is only now and then that they form the subject of communications to societies. In regard to this colony, the fact is that till the publication of Miers' Catalogue of the New Zealand Crustacea in the British Museum, our knowledge of the whole class was fragmentary and scattered throughout numerous works. Now, however, that all the information on the subject has been thus collected and published in a condensed form, it becomes more easy to fill up the existing gaps.

The Entomostraca are an interesting and but little studied division of Crustaceans, and from their abundance are of considerable importance. The species enumerated here have been collected chiefly within a few miles of Dunedin, and the marine forms only between tide marks; so that we are as yet only on the threshold of the subject.

Examination of other portions of the Islands, and particularly the use of the dredge at various depths of the ocean, will certainly reveal many other forms.

For subsequent reference, I have here tabulated the characters of the whole family.

Sub-class Entomostraca.

Legion I. Lophyropoda. Branchiæ attached to the organs of the mouth; legs few, not exceeding five pairs, serving for locomotion; articulations mostly more or less cylindrical; antennæ two pairs, one pair used as organs of motion.

Order I. Ostracoda. Shell consisting of 2 valves, entirely enclosing the body; feet 1–3 pairs, adapted for progression; no external ovary.

Sect. I. Podocopa. Inferior antennæ simple, subpediform, geniculate, clawed at the end.

Fam. 1. Cypridæ. Superior antennæ mostly seven-jointed, with a dense brush of long setæ; eye single; feet two pairs, the last bent up between the valves; abdominal rami two, elongate, clawed at the end.

Genus I. Cypris, *Müller.*

Upper antennæ seven-jointed, with numerous long plumose setæ. Lower antennæ five-jointed, furnished with a brush of setæ, and terminated by four long, serrated claws. Second pair of jaws possessing a branchial plate, and a sub-conical obscurely-jointed palpus, ending in three long setæ. Post-abdominal rami long and slender, terminating in two strong, curved claws. Animals free-swimming, mostly found in fresh or slightly brackish water.

1. ***Cypris novæ-zealandiæ*, Baird.**

Cypris novæ-zealandiæ, Baird. Dieffenbach's N. Z., vol. ii, p. 268.

"Shell ovate, elongated, both extremities of the same size, somewhat turgid and slightly sinuated in the centre of anterior margin, white, smooth and shining, perfectly free from hairs."

This may be the species described next, as the valves bleach after the animal dies, and lose their hairs. The shape, however, is not quite the same, and the whole description is too meagre to found any identification upon.

The following three species belong to Brady's *Section a*, and agree in the following characters:—

"Setæ of lower antennæ plumose, subequal, reaching about as far as, or only slightly beyond, the apex of the terminal claws. Second foot terminating in a short, hooked claw, and one or more moderately long setæ."

2. *Cypris ciliata*, nov. sp. Fig. A.1 *a–g*.

Valves oval-elliptical, slightly narrowing anteriorly, high in the middle, very convex; greatest height less than two-thirds of the length. Margin finely denticulated on the inside, thickly fringed with fine hairs. Surface more or less hairy, minutely granular; when examined under a high power it appears closely reticulated. Colour very variable, ranging from whitish yellow to dark brown, more or less marked with brown, and sometimes with irregular black dots, varying chiefly with the nature of the mud of the pools in which the animals occur. Valves rather opaque, seldom semi-transparent. Setæ of second pair of legs about as long as terminal joint. Post-abdominal rami long and slender; their claws long and pectinately toothed; the uppermost seta nearly as long as the claw next it, terminal seta about half as long.

Length $\frac{1}{18}$ inch; height $\frac{1}{37}$ inch.

Very common in all stagnant fresh water near Dunedin. Wellington (T. W. Kirk). Probably the most abundant form in New Zealand. I have not found it in running streams. October to April or May.

3. *Cypris viridis*, nov. sp. Fig. A.2 *a–g*.

Valves broadly reniform, rounded at the extremities, slightly hollowed on the lower margin, elevated in the centre of the upper margin; greatest height about equal to three-fourths of the length. Viewed from above the valves are very convex posteriorly, broadly ovate in form, and tapering to the anterior extremity. Margins and surface clothed with hairs. Colour a dirty green, varying in intensity; substance of the valves quite opaque. Under a high power the surface appears to be minutely granular. Setæ of second pair of legs short. Post-abdominal rami very slender; the claws unequal, and also very slender. Length $\frac{1}{20}$ inch; height $\frac{1}{32}$ inch.

Not uncommon in pools about Dunedin and Taieri Plain.

To be found all the year round. I have taken it in blocks of ice, and found it quite lively as soon as its covering was thawed.

4. *Cypris littoralis*, nov. sp. Fig A.3 *a–b*, and B.1 *a–d*.

Valves narrow oblong, compressed; lower margin nearly straight, upper evenly and slightly arched, highest in the middle; greatest height equal to less than half the length. Surface and margins quite smooth. Colour yellowish-grey, dotted with irregular black or brown spots. Valves semi-transparent. Terminal setæ of second pair of legs very long and glumose. Post-abdominal rami long, slender and smooth; the two large terminal claws bearing three stout teeth near their apex.

Length $\frac{1}{30}$in.; breadth $\frac{1}{75}$in.

This minute and very distinct species was found in pools of brackish water at Blueskin, north of Dunedin. The specimen figured was a male;

owing to the transparency of the shell the mucus-gland (testis ?) could easily be seen.

Fam. II. Cytheridæ.

Superior antennæ five- to seven-jointed, armed with setæ or spines; inferior antennæ four- to five-jointed, without a brush of setæ. Three pairs of feet, all very much alike, adapted for walking. Post-abdomen rudimentary, consisting of two very small lobes.

Genus I. Cythere, *Müller.*

Shell usually thick and strong, with a more or less rough and uneven surface. Superior antennæ five- to six-jointed, spiniferous; inferior antennæ four-jointed. Mandibular palpus three- to four-jointed, and furnished with a tuft of from two to five setæ. Internal lobe of first maxillæ well developed.

1. *Cythere atra*, nov. sp. Figs. A.2 and C.1.

Valves subreniform, highest behind the middle, narrowing anteriorly, rounded posteriorly; when viewed from above, narrow-oblong, evenly convex, tapering to a subacute apex anteriorly, more obtuse posteriorly. Examined under a high power, the shell is seen to be sparsely covered with circular translucent spots, which appear black when the animal is within. Margin fringed with very short close cilia. Colour nearly black, opaque, except near the margins. Limbs yellowish. Superior antennæ 6-jointed, last joint small, three preceding subequal in length, setæ short; second joint fringed with minute hairs on lower margin. Inferior antennæ stout, with the last joint very short; terminal claws short and uneven; urticating seta bi-articulate, reaching to the extremity of the antenna. Limbs similar in shape, lengthening posteriorly. Length $\frac{1}{40}$ inch; height $\frac{1}{70}$ inch.

Among *Algæ* in shallow water. Otago Harbour.

2. *Cythere truncata*, nov. sp. Fig. C.2 *a–c*.

Valves sub-quadrilateral, highest in front, lower margin slightly hollowed in the middle, anterior extremity very wide and rounded, middle of upper margin falling slightly away; posterior extremity with its upper half hollowed out into a deep oblique notch. When viewed from above, the valves are elongate-quadrilateral in outline, obtuse in front, sides nearly straight, and about even in width to the posterior angle, where they suddenly fall away to the margin. Whole anterior margin fringed with broad, curved, and flat teeth, the rest all smooth. Surface irregularly pitted and grooved, marked with circular dots. Greatest height barely equal to half the length. The limbs of the animal are brownish-yellow in colour. Last joint of upper antennæ only half as long as preceding; terminal setæ stout. Urticating seta of lower antenna short, only reaching to middle of third joint, uniarticulate. Mandibular palp bearing three curved and pectinately

fringed setæ. Terminal claws of the legs long and curved, those of last pair pectinately toothed. Abdominal lobes terminating in two short, unequal, fringed setæ.

Length $\frac{1}{36}$ inch; height $\frac{1}{65}$ inch.

In *Algæ* along with preceding species. Otago Harbour.

Genus 2. Loxoconcha, *G. O. Sars.*

Valves sub-rhomboidal in shape, surface usually marked with fine concentric pittings and circular papillæ; ventral margins forming a thin and more or less prominent keel behind the middle; posterior dorsal margin obliquely truncate. Limbs of the animal slender and colourless. Upper antennæ very slender, six-jointed, last joint very long, linear and bearing long, simple setæ; lower antennæ four-jointed, third joint long and narrow; flagellum long and bi-articulate. Mandibular palp three-jointed, bearing a distinct branchial appendage. Lowest seta of the branchial plate of first pair of jaws deflexed. Abdomen terminated by a hairy, conical process; postabdominal lobes bearing two moderately long, subequal setæ.

"The genus is well characterised by the oblique 'peach-stone' outline of the carapace, and by the very slender setose, but non-spinous limbs of the animal."

1. *Loxoconcha punctata*, nov. sp. Fig. B.3 *a–k*.

Valves of the male sub-rhomboidal; greatest height less than two-thirds the length; extremities obliquely rounded, whole lower margin more or less flattened and keeled, minutely ciliate. Viewed from above, evenly convex, widest in the middle, and tapering to both ends. Surface marked with dark spots and numerous translucent punctations. Colour greyish, shining and somewhat translucent. Valves of the female rather longer, more reniform in outline and usually much more opaque; keel not so prominently flattened. Hinge processes well marked; intervening portion of margin crenulated. Eyes distinct and separate. Superior antennæ very sparingly setose: setæ long. Third joint of inferior antennæ with two setæ above the middle of the posterior margin, and pectinately toothed towards the extremity. Urticating setæ reaching to extremity of antennæ; glands large. Terminal claws of all the feet long and curved. Length $\frac{1}{30}$ inch; height $\frac{1}{48}$ inch.

Among seaweed, along with the two preceding species of *Cythere*, in Otago Harbour.

This appears to be a very variable species, particularly in the texture of the shell. In some the valves are nearly translucent, while gradations can be traced up to complete opacity.

Sect. II. Myodocopa.

Inferior antennæ two-branched; one branch rudimentary, the other powerful, many-jointed, with long natatory setæ; mandibular palp very

large, sub-pediform, geniculate, not branchial. Post-abdomen with two broad plates, clawed.

Fam. I. Cypridinidæ.

Superior antennæ large, many-jointed, setiferous at the extremity. Inferior antennæ with the natatory branch nine-jointed, and furnished with ciliated setæ. Mandibles rudimentary; palp large, pediform, four-jointed. Second pair of jaws with a large branchial plate. One pair of feet, vermiform, annulated and armed with prickly spines at the apex, oviferous. Two compound eyes, and one large simple eye.

NOTE.—In the Zoological Society Proc. for 1850, at p. 255, Mr. Baird has described, from the dried and bleached valves, a species of *Cypridina* (?) Not having seen his drawings, I am unable to say whether it is the same as the species described by me, as *Philomedes agilis*. The following is Baird's description:—

"*Cypridina zealanica*, Baird.

Carapace valves of an oval form, somewhat flattened, but convex in the centre and striated; the striæ are numerous, close-set, and of a waved appearance. Surface of valves covered with minute punctations, which probably give origin in the fresh state to short hairs, though they are not visible in the dried specimens. The anterior extremity is slightly narrower than the posterior. The whole carapace is of a uniform white colour. Natural size one-fourth of an inch long, and one-fifth of an inch broad.

Hab.—New Zealand. Two specimens were sent to the British Museum by the Rev. R. Taylor of Waimate in New Zealand, along with a collection of marine and freshwater shells, but without any history attached to them."

At p. 102 of the same volume this species is described as *C. zealandica*.

Genus I. Philomedes, *Lilljeborg.*

Cypridina, Baird. Brit. Entom., p. 176.

Philomedes, Lilljeborg; G. O. Sars; Norman; Brady, Zool. Soc., Proc. 1871, p. 291.

Shell of moderate strength and density. Superior antennæ six-jointed; in the female short and thick, and bearing several subequal terminal setæ of moderate length; in the male more elongated, two of the terminal setæ of excessive length, the antepenultimate joint bearing a stout and densely setose auditory filament. Natatory branch of lower antennæ nine-jointed; in the female having the first joint very long, the rest short and subequal; in the male the first and third joints long, the second much shorter, the rest short and subequal; secondary branch in female indistinctly jointed, setose; in the male long, three-jointed, cheliform. Mandibular feet nearly alike in both sexes; in the female armed with mandibuliform processes and spines, in the male bearing on the basal joint a small tubercle with two short hairs; second pair of jaws in the female armed with mandibuliform processes. Eyes of the female small and pale-coloured; of the male large, deep-red, and multilenticular.

1. *Philomedes agilis*, nov. sp. Fig. C.3 *a-e*, and D.1 *a-g*.

Male.—Valves, when viewed from the side, oblong; greatest height about two-thirds of the length, obtusely rounded posteriorly, beak not greatly produced anteriorly; superior and inferior margins evenly and slightly arched; oral notch wide, margins more or less setose. When viewed from above the valves are narrow, sides nearly parallel, almost truncate posteriorly, tapering to an obtuse point in front. Surface marked with numerous circular pits, and several translucent spots in the centre of each valve. Behind each prominent eye-spot, is a more or less deep transverse sinus or depression, extending nearly across the whole valve. Colour of shell yellowish-brown. Terminal setæ of upper antennæ nearly half as long as the antennæ itself. Natatory branch of inferior antennæ (exclusive of setæ) exceeding in length the basal portion, second joint very short, bearing a straight plumose seta, equal in length to the third joint, which again is longer than the next six joints; terminal setæ about as long as the branch itself. Secondary branch with the basal joint short and stout, bearing short plumose setæ; second and third joints subequal, former with two setæ in the middle of external margin, latter curved, external margin denticulate and with a single seta on its inner margin near the base. Last joint of mandibular foot slender, twice as long as preceding, terminal claw subequal to it; all the joints bearing several plumose setæ. "Oviferous feet" terminating in a vermiform toothed extremity, bearing a pair of long spinose setæ above and three beneath; about five pairs of shorter spinose setæ on the annulated portion near the extremity. Post-abdominal laminæ terminated by three large jointed and doubly-serrated claws,—the first very long, second only half as long, and third about half as long as second,—and about five smaller spines. Eyes large black.

Female.—Valves somewhat larger, and much more circular in outline, with the beak small and very slightly produced; oral notch nearly rectangular; height about three-fourths of the length; easily distinguished externally from the male by the small size of the eye-spot. Superior antennæ with the setæ at the extremity of the antepenultimate joint beautifully plumose. Natatory branch of the inferior antennæ with the first joint very long; all the rest short and subequal; no setæ on the first three joints, those on the fourth, fifth, and sixth joints about as long as the basal joint and bluntly toothed; the remainder (seven in number) very long and densely plumose; secondary branch rudimentary, with a few small setæ. Eyes reddish.

Length $\frac{1}{12}$ inch; height $\frac{1}{21}$ inch.

Swimming actively in rock pools on the Taieri Beach.

Order II. Copepoda.

Shell jointed, forming a buckler enclosing the head and thorax; legs five pairs, mostly adapted for swimming; ovary external.

Fam. I. Cyclopidæ.

Head consolidated with thorax; foot-jaws two pairs, generally small; fifth pair of legs rudimentary; eye single; both of the superior antennæ in the male furnished with a swollen hinge-joint.

Genus I. Cyclops, *Müller.* Fig. D.2 *a–l.*

Foot-jaws large and strong, branched; inferior antennæ simple; external ovaries two.

1. *Cyclops novæ-zealandiæ*, nov. sp.

Female.—Cephalothorax greatly exceeding in length the three following segments, produced downwards in front into an obtuse beak. All the body segments rounded on their postero-lateral margins; segments of the abdomen slightly produced posteriorly above and below, last segment with the whole posterior margin finely serrated. Superior antennæ fourteen-jointed; last five articulations long and slender. Each joint furnished with one or more setæ, which are most abundant on the basal joints; terminal joint with one long and four shorter setæ. Inferior antennæ four-jointed; first joint bearing at its extremity a long plumose seta, which exceeds the rest of the antenna in length; second nearly smooth; third with the inferior margin sinuously curved and bearing about eight setæ; last joint terminated by seven unequal setæ. Mouth organs as in *C. quadricornis.* Last pair of legs two-jointed; basal joint very short; second sub-triangular in shape and bearing three setæ, the longest of which is plumose. Caudal lamellæ about four times as long as broad, with a line of serrations down the outer margins. Setæ sparingly ciliated near the base, but becoming beautifully plumose towards the middle and extremities; inner seta longer than the abdomen, about eight times as long as the lamellæ; outer seta about five times as long as lamellæ; a short-toothed seta on the outer margin at the extremity; two more on the inner margin. Ovaries usually of a slate blue colour, broadly oval, only about half as long as the abdomen, and diverging somewhat widely from it.

Male.—Smaller than the female and more active, similar in shape, but readily distinguished by the shape of the superior antennæ. These have the joints much more crowded together, and very flexible. Antepenultimate joint not setiferous; ultimate joint having about eight setæ on one side, the last (and longest) being somewhat removed from the smooth extremity. These last two joints have an extremely flexible hinge, and can be bent completely back so as to lie against the preceding joints. Fifth pair of legs as in the female.

Colour usually yellowish and semi-transparent, with numerous red or brown oil globules; sometimes so encrusted with diatoms and confervoid

growths as to be bright green. Eye usually red, sometimes brown or nearly black. Length, exclusive of caudal setæ, about $\frac{1}{20}$ inch. Occurs all the year round.

This is a very common species, occurring in every little pool, and even in brackish water affected by the tide. It is extremely lively in its movements, and avoids danger with much more alacrity than the majority of the Entomostraca, darting away on the approach of a dipping-tube or other large object.

From the figure in Dana's Atlas of Crustacea (U.S. Explor. Exped.), this species appears to be very near *C. vitiensis*, Dana. I have not seen any description however.

Genus II. Arpacticus, *Baird.*

Foot-jaws forming strong cheliform hands; inferior antennæ simple. Ovary single.

1. *Arpacticus bairdii*, nov. sp. Fig. D.3, and Fig. E.1.

Body indistinctly ten-jointed. Cephalothorax produced downwards into a beak. Eye usually crimson. Superior antennæ stout, composed of ten articulations, the last seven subequal in length, but greatly narrowing, bearing numerous setæ, which are particularly abundant on the third, fourth, fifth, and sixth joints; one very long and stout seta from the fourth joint; last joint terminated by about five setæ of different lengths. Lower antennæ two-jointed; basal joint with a two-jointed, setiferous appendage; ultimate joint with about nine long setæ. Mandibles strong. Posterior foot-jaws three-jointed; second joint ovate, with a broad, flat margin furnished with two rows of small teeth; third joint in form of a strong hook. First pair of feet with both branches three-jointed, external branch having the first joint short, bearing one strong seta, second much longer, with seta on each side, last joint very short and terminated by about five somewhat curved setæ, the largest of them being somewhat serrated on its inner margin; internal branch with first joint very long, second short, and third in the form of a long, slender hook. Second, third, and fourth pairs of legs somewhat similar in shape, with the external branch in each longer than the internal, and all furnished with numerous setæ, the longer of which are beautifully plumose. Fifth pair with both branches formed of a single, nearly circular joint, bearing five setæ at the extremity. All the legs more or less serrated on the margins. Abdomen cylindrical, tapering posteriorly; posterior margins of segments minutely serrate. Bilobed extremity bearing on each side one seta, which exceeds the abdomen in length, one about a third as long, and four short ones. Ovisac large, usually exceeding the abdomen in diameter, and reaching to about the penultimate segment.

Length $\frac{1}{30}$ of an inch.

Occurs abundantly among shore-algæ in Otago Harbour.

Legion II. Branchiopoda.

Branchiæ attached to the legs; legs from four to sixty pairs.

Order I. Phyllopoda.

Legs from eleven to sixty pairs in number; joints foliaceous and branchiiform, chiefly adapted for respiration and not motion; eyes two or three, sometimes pedunculated; antennæ one or two pairs, neither adapted for swimming.

Fam. I. Apodidæ.

Feet sixty pairs. Antennæ—only one pair—short, styliform. Eyes two, sessile. Body multi-articulate, the greater part covered by a shield-like carapace.

Genus I. Lepidurus, *Leach.*

Last segment of the body produced into a lamina, which projects to some distance between the caudal filaments. First pair of legs short.

1. *Lepidurus kirkii*, nov. sp. Fig. E.4.

Carapace very broadly oval, covering nearly the whole abdomen, very membranous. Keel visible along the whole back, becoming more prominent at its posterior extremity. Posterior notch with from eleven to thirteen acute teeth, inter-dental portions smooth. Edges of the carapace very slightly serrated towards its posterior angles. Appendages of the first pair of feet more developed than is usual in the species of this genus, external branch being about one-fourth as long as the carapace. Segments of the abdomen studded with a row of numerous, stout, curved spines. Caudal lamella oval, evenly rounded at the extremity, margins finely and acutely serrate; dorsal row of spines extending about two-thirds of its length. Caudal setæ more than half as long as the body, densely hirsute. Colour pale olive green. Length, including caudal lamella, 1·25 inch; breadth of carapace (about) ·75 inch.

Wellington, T. W. Kirk, junr.

2. *Lepidurus compressus*, nov. sp. Fig. E.5.

Carapace oval, not spreading, but somewhat arched, hardly covering the abdomen, keeled only at the extremity. Posterior notch very deep, with about twelve very small teeth, and minute serrations between. Lower margin of carapace smooth. Appendages of first pair of feet short, hardly extending beyond edge of carapace. Segments of abdomen with a row of small, straight spines. Caudal lamella as in the previous species, but with the keel extending to its extremity, and sparingly toothed. Caudal setæ densely hirsute, not half as long as the body. Colour dark olive green. Length ·8 inch; breadth only about ·3 inch.

Collected by Prof. Hutton in pools at Waikouaiti, and at Queenstown (Lake Wakatipu.)

It is with considerable hesitation that I advance the above as distinct species. As Sir John Lubbock states (Linn. Soc. Trans. Vol. XXIV., p. 206), the relative length of the carapace and the form of the caudal lamella vary so much in different individuals, even when taken from the same pool, that they do not constitute good characters on which to found new species. Though the specimens examined by me were sufficiently distinct to be readily recognised and separated into two lots without any close investigation, yet I am inclined to think that both constitute only varieties of a wide-spread species. In fact, I should be inclined to include under one species, *L. productus*, Bosc., from Europe, *L. viridis*, Baird, from Tasmania, *L. angasii*, Baird, from South Australia, and perhaps even *L. glacialis*, Kroyer, from North America.

Order II. Cladocera.

Legs four to six pairs, chiefly branchial; eye single and very large; antennæ two pairs, inferior large, branched, and adapted for swimming.

Fam. I. Daphniadæ.

Superior antennæ small; inferior large, two-branched; legs five (or six) pairs, all enclosed within the carapace.

Genus I. Daphnia, *Müller.*

Head produced downwards into a more or less prominent beak. Superior antennæ exceedingly small, one-jointed, and situated under the beak; inferior large and powerful.

1. *Daphnia obtusata*, nov. sp. Fig. E.2 *a-e.*

Carapace (viewed laterally) oval, broadest below the middle, obtusely pointed below, infero-anterior margin oblique; anterior margin rounded, finely ciliated. When viewed dorsally, the valves are narrow-obovate in shape, tapering downwards. Head small, produced into a very obtuse beak. Inferior antennæ comparatively small as compared with European species, not more than one-fourth the length of the carapace. Superior antennæ very minute, thick and slightly curved, with a few very delicate cilia at the extremity. Eye moderately large. Abdominal segment bearing two slender filaments. Caudal claws long, slender and curved, serrated below. Lower edge of abdomen with numerous curved teeth.

The whole carapace is semi-transparent and closely striated.

Length $\frac{1}{12}$ inch. Occurs in great abundance in still water in neighbourhood of Dunedin from October to May.

The young are very abundantly produced, over thirty sometimes occurring within the valves of the parent. Before leaving this shelter they are remarkably well-developed and able to swim about freely. At this early stage the carapace is subquadrate in shape, and both pairs of antennæ are relatively large, the inferior being nearly as long as the animal.

This species is very distinct in general shape from any European form, which are all more or less acutely produced inferiorly, and it also has the antennæ very much shorter than is usual in the genus.

Fam. II. Lynceidæ.

Superior antennæ very short; inferior of moderate size, branched, each branch three-jointed; legs five pairs; eye single, with a black spot in front; intestine convoluted, having one complete turn and a half.

Genus I. Chydorus, *Leach.*

Nearly spherical in shape; beak very long and sharp, curved downwards; inferior antennæ very short.

1. *Chydorus minutus*, nov. sp. Fig. E.3 *a*.

Carapace broadly oblong in young specimens, becoming more spherical in adults, dorsally rounded; antero-inferior margin oblique, fringed with rather long cilia. Beak long, very acute. Eye rather small; eye-spot not half as large. Superior antennæ very small, blunt, with a few very delicate setæ. Inferior antennæ short; lower branch with two setæ from extremity of last joint; upper branch with one seta from the penultimate joint, and three from the last joint. Abdomen strongly serrated on the inferior margin, with the terminal claws short and curved. The postero-dorsal border of the abdomen furnished with two filaments. Length about $\frac{1}{50}$ of an inch.

Very common in ditches, ponds &c., near Dunedin, from October to May.

In the larger specimen figured, a solitary young one was inside the carapace of the parent. This was well-developed, having the eye and eye-spot prominent, and apparently all the limbs perfect.

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DESCRIPTION OF PLATE XI.

(The small numbers represent the linear magnifying power.)*

Fig. A. 1. *Cypris ciliata:* (*a*) superior antennæ; (*b*) inferior antennæ; (*c*) portion of mandible; (*d*) first pair of feet; (*e*) second pair of feet; (*f*) post-abdominal ramus; (*g*) portion of valve.

2. *Cypris viridis:* (*a*) superior antennæ: (*b*) inferior antennæ; (*c*) portion of mandible; (*d*) first pair of feet; (*e*) second pair of feet; (*f*) post-abdominal ramus; (*g*) portion of valve.

3. *Cypris littoralis:* (*a*) mucus-gland (of Brady); (*b*) post-abdominal ramus.

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* These numbers should be reduced by *one-half*, as the original plates have been reduced to that extent.—Ed.

ENTOMOSTRACA

Fig. B. 1. *Cypris littoralis:* (*a*) superior antennæ; (*b*) inferior antennæ; (*c* and *d*) first and second pair of legs.

2. *Cythere atra:* (*a*) portion of valve; (*b* and *c*) legs of first and second pairs.

3. *Loxoconcha punctata:* (*a*) superior antennæ; (*b*) inferior antennæ; (*c*) mandible; (*d*) maxillæ; (*e*) third pair of legs; (*f*) outer margin of valve; (*g*) hinge-line; (*h*) abdominal lobe; (*k*) post-abdominal ramus.

Fig. C. 1. *Cythere atra:* (*a*) superior antennæ; (*b*) inferior antennæ.

2. *Cythere truncata:* (*a*) superior antennæ; (*b*) inferior antennæ; (*c*) mandible.

3. *Philomedes agilis:* (*a*) central portion of valves showing lucid spots; (*b*) portion of seta on natatory branch of lower antennæ, female; (*c*) secondary joint of lower antennæ, male; (*d*) same, female; (*e*) extremity of oviferous foot.

Fig. D. 1. *Philomedes agilis:* (*a*) superior antennæ, male; (*b*) same, female; (*c*) natatory branch of inferior antennæ, male; (*d*) same, female; (*e*) mandibular foot; (*f*) post-abdominal laminæ; (*g*) second maxillæ.

2. *Cyclops novæ-zealandiæ*, female: (*a*, *b*) superior and inferior antennæ; (*d*) second foot-jaws, outer branch; (*e*) inner branch; (*f*) leg of third pair; (*g*) leg of fifth pair; (*h*) caudal lamellæ and setæ; (*k*) second segment of abdomen with triple spines; (*l*) superior antennæ of *male*.

3. *Arpacticus bairdii*, female: (*a*) foot-jaws; (*b*) first pair of legs.

Fig. E. 1. *Arpacticus bairdii*, female: (*a*) inferior antennæ; (*b*) superior antennæ; (*c*) cephalothorax from above; (*d*) third pair of legs; (*e*) fifth pair of legs; (*f*) abdominal segments and caudal setæ.

2. *Daphnia obtusata:* (*a*) head, seen from above; (*b*) superior antennæ; (*c*) mandibles; (*d*) extremity of abdomen; (*e*) young, taken from carapace of parent.

3. *Chydorus minutus:* (*a*) inferior antennæ; (*b*) superior antennæ; (*c*) extremity of abdomen.

4. *Lepidurus kirkii:* (*a*) foot of the first pair.

5. *Lepidurus compressus:* (*a*) foot of the first pair.

ART. XXII.—*On* Desis robsoni, *a Marine Spider, from Cape Campbell.*

By LLEWELLYN POWELL, M.D.

[*Read before the Philosophical Institute of Canterbury, 7th November*, 1878.]

Plate XII.

IN the tenth volume of the Transactions, p. 299, is a short description of a spider, discovered inhabiting old *Lithodomus* holes, beneath the surface of tidal pools, by Mr. C. H. Robson, at Cape Campbell. Dr. Hector in a note states that this spider is allied to the genus *Argyroneta*, and proposes for it the name *Argyroneta marina*.

It scarcely needs more than a glance, however, at the lip and maxillæ to decide that this interesting spider does not belong to *Argyroneta*, but, indeed, that in the form of these appendages it differs very strikingly from that genus. Dr. L. Koch describes two closely allied species (Arachniden Australiens, p. 345–351, plate xxix., figs. 1 and 2) referring them to the genus *Desis*, founded by Walckenaer on a single species, *Desis dysderoides* from New Guinea.

The following are the characters of the genus *Desis*, as given by Walckenaer.*

"Eyes eight, in two lines, the anterior very close to the anterior margin of the cephalothorax, curved backwards, and forming an open crescent; the eyes forming the intermediate square, larger than the lateral eyes, which are situated on a slightly raised tubercle.

"Lip elongated, with parallel sides, deeply notched at its extremity.

"Maxillæ straight, diverging, dilated at their base, pointed at their extremity.

"Legs strong, suited for running; the anterior longer than the posterior; the first pair the longest, the second next, the third pair the shortest."

The above characters are supplemented in the description of the species *Desis dysderoides*, which I subjoin.

"Abdomen oval, convex above and below, of a uniform pale grey. Cephalothorax, mandibles, sternum, legs and palpi coral red. Mandibles long and strong, directed forwards.

"New Guinea. Quoy and Gaimard.

"Aspect of *Dysdera erythrina*. Cephalothorax as long and as large as the abdomen, sides almost parallel, scarcely at all narrowed anteriorly, flattened. Sternum without spots, without eminences, and clothed at the insertion of the legs with yellow hair. The mandibles are very strong, directed forwards as in *Dysdera*, as long as the cepthalothorax, cylindroid, with the claws of a red brown, elongated, half opened and not completely folded back in the groove, which last is toothed. The teeth are prominent and number eight or nine as in *Dysdera erythrina*. The legs have the tarsus provided with three claws, of which one is very short and almost hidden in the hairs." †

The agreement of our spider with the above characters is so close that there can be no doubt as to the propriety of placing it in this genus.

Desis robsoni, nov. sp.

Male.—Cephalothorax moderately dark mahogany brown, darkening towards the facial border, paling towards the sides and posterior border of the thorax, sparingly clothed with short hairs. Angles of the caput bordered with black.

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* Histoire des Aptères, Vol. I, p. 610, plate iv., figs. 15 *a* and *b*.

† Histoire des Aptères, Vol. I., p. 611.

Falces a rich red brown, glabrous above, hairy beneath, inner and upper border fringed with long coarse dark hairs. Fangs very dark red brown, nearly black proximally.

Sternum yellowish brown, with a dark edge, clothed with yellowish white hairs.

Lip and maxillæ reddish brown, both with a pale border anteriorly, clothed with yellowish white hairs, inner border of maxillæ fringed with long coarse dark hairs.

Abdomen greenish grey, in some specimens yellowish grey, paler beneath, thickly clothed with yellowish white and dark hairs intermixed.

Coxal joints of legs yellowish brown. Legs otherwise same colour as abdomen but yellower, anterior pair inclining to brown, in some specimens much browner than in others.

Palpi yellowish brown.

Cephalothorax nearly one and two-thirds longer than broad, sides nearly parallel, scarcely contracted anteriorly, and cut off nearly square, sides of thorax only slightly rounded; longitudinally a very flat uniform convexity above, becoming somewhat more abrupt anteriorly, transversely only moderately convex. Normal grooves of thorax feebly indicated by darkish lines. A short deep median groove to thorax.

Mandibles equalling the cephalothorax in length, directed nearly straight forwards, cylindroid and robust, immediately beyond their origin on upper and outer side is a small prominent ovoid boss.

Upper border of groove for fang, armed with six teeth, the first small and rather remote from extremity, the second the largest of all, the other four smaller and regularly diminishing. Lower border armed with two teeth, the first close to the insertion of the fang, moderately large, the second quite small and on a level with the first of the upper border. Fang long, rather straight. Eyes of very uniform size, the posterior middle pair being the smallest; disposed in two rows, the anterior straight or curved very slightly indeed, the opening of the curve being forward. The posterior row nearly straight, but in consequence of the small size of the middle pair a line touching their posterior margins would be slightly concave backwards.

Anterior middles less than own breadth from border of face, lateral middles almost on border. Anterior middles separated from one another by own diameter, and from laterals by more than twice own diameter. Posterior middles more than own distance from anterior middles and nearly four times own diameter apart, the same distance from posterior laterals. Lateral eyes barely their own diameter apart. Anterior middles situated on a slight common eminence, they look directly forwards; anterior laterals

situated on a very slight eminence common to them with the posterior laterals, they look forward and slightly outwards. Posterior middles look upwards, posterior laterals upwards and outwards.

Sternum a long heart-shape, flat, with concave emarginations opposite the coxæ.

Lip twice as long as broad, tongue-shaped, sides nearly parallel, but narrowing somewhat anteriorly, towards its origin it is pinched in and then widens to its insertion. Its anterior border is notched.

Maxillæ cut obliquely away from the lip and running to a sharp point anteriorly, outer border rounded, pinched in anteriorly to the insertion of the palpi, flattish, but becoming more convex towards their insertion. Abdomen ovoid. Spinnerets short, diverging, the upper and lower pair rather longer than the middle pair. Legs long, slender, clothed with yellowish white hairs intermingled with bristles at distal end of third and fourth tibial joints.

Tarsi have three claws, the two principal claws deeply combed, the posterior claw small, inconspicuous, not combed, and abruptly bent just beyond its origin.

Male palpi long, slender. The radial joint has on its outer side a bifurcate process, the lower segment thin, broad, and flattened, yellowish, with the upper border thickened, and dark brown, the upper segment thick, very much narrower than the lower segment, from which it is slightly turned away, blunt at its point, dark brown. The digital joint ovoid, prolonged, and tapering distally, and provided at its extremity with short, stout spines; the palpal organ has a coiled cirrhus about three-fourths the circumference of the organ in length. The palpi are clothed with abundant long hairs.

MEASUREMENTS.

	M.	
Total length	0·015	
Cephalothorax	0·0042	
Falces	0·0042	
Abdomen	0·005	
Leg of 1st pair	0·0145	verified exact in a second specimen.
" 2nd "	0·01	
" 3rd "	0·009	
" 4th "	0·0105	
Male palpus	0·0075	

Female.— Colouring as male. Cephalothorax more convex above. Falces slightly shorter but more massive. Fang thicker and stronger. Epigyne pale-yellowish. A small concavity with a denticle on either side pointing inwards, posteriorly a short blunt process directed backwards.

Desis robsoni is excedingly like *Desis martensii* (Koch, Arachn. Austral.), which it also resembles in its marine habits. This is so interesting that I make no apology for quoting Dr. Koch's remarks in full:—

"I received from Dr. E. v. Martens, of Berlin, a third species of this interesting genus (*Desis martensii*). It was collected by him on coral reefs at Singapore, and kindly given to me for examination. This species is remarkable in that it has established itself in these reefs which are only temporarily uncovered by the sea; Herr v. Martens has found many specimens of the spider in this locality. * * * * * * * * * That the species discovered by Dr. E. v. Martens and Dr. Johswick,* can really, like our indigenous *Argyroneta aquatica*, Cl., live under water, is to me doubtful in the highest degree, for it is wanting in the outward visible signs of the breathing apparatus which corresponds to such submarine mode of life, and which has been anatomically demonstrated in *Argyroneta aquatica*†. It also speaks against it that yet another species of spider, an *Atta*, was found on the same coral reefs, and we may assume with all certainty that this is a true terrestrial form. I opine that these spiders, perhaps, in former times, were floated in an accidental manner from the land to these reefs, and now live in the holes of the coral bank, within which they withdraw at the time of flood, and which they close against the entrance of the water with a thick web. * * When once both sexes had been transferred to the coral reefs, *Desis martensii* would increase and form a colony there."

I take the liberty of quoting a further valuable communication from Dr. E. v. Martens on the discovery of this interesting spider, as follows:—

"During my residence at Singapore, in October, 1861, I repeatedly visited a coral bank in the neighbourhood of New Harbour, of which large tracts were exposed above water during the ebb, at the times of new and full moon. My attention was chiefly directed to Crustacea and Mollusca; I tore off pieces of coral and broke them up to get at the creatures hidden within. To my astonishment I several times observed spiders hurriedly escaping, the idea occurred to me at first that we ourselves had brought them from the shore in our clothing. I generally went with the late staff-surgeon, Dr. Johswick, in a little skiff pulled by a Chinese from the frigate 'Thetis' which lay in the roadstead, or from the town, distant about half-a-league from the coral reef. This suspicion was rendered unlikely by the frequent repetition of the event, and conclusively disproved, as Dr. Johswick found a web of undoubtedly one of these spiders in an old dead mussel shell, between the coral, stretched sheet-like in the cavity of the shell."‡

* Sitzungsbericht der Gesellschaft Naturforschender Freunde zu Berlin vom Mai 24, 1864, p. 10.

† Grube "Einige Resultate aus Untersuchungen über die Anatomie der Spinnen," in Müller's "Archiv. für Anat. und Physiologie," 1842, p. 300; und Menge "Ueber die Lebensweise der Arachniden," "Neueste Schriften der Naturhistorischen Gesellschaft," in Danzig, IV. Band Hft. i, p. 23.

‡ Koch, Arach. Austr., pp. 349, 350.

The discovery of *Desis robsoni*, and its highly aquatic and marine habits, clear up Dr. Koch's doubts as to the voluntarily aquatic habitat of *Desis martensii*.

In reply to some enquiries of mine, Mr. Robson gives the following additional information as to the mode of life of this interesting spider :—

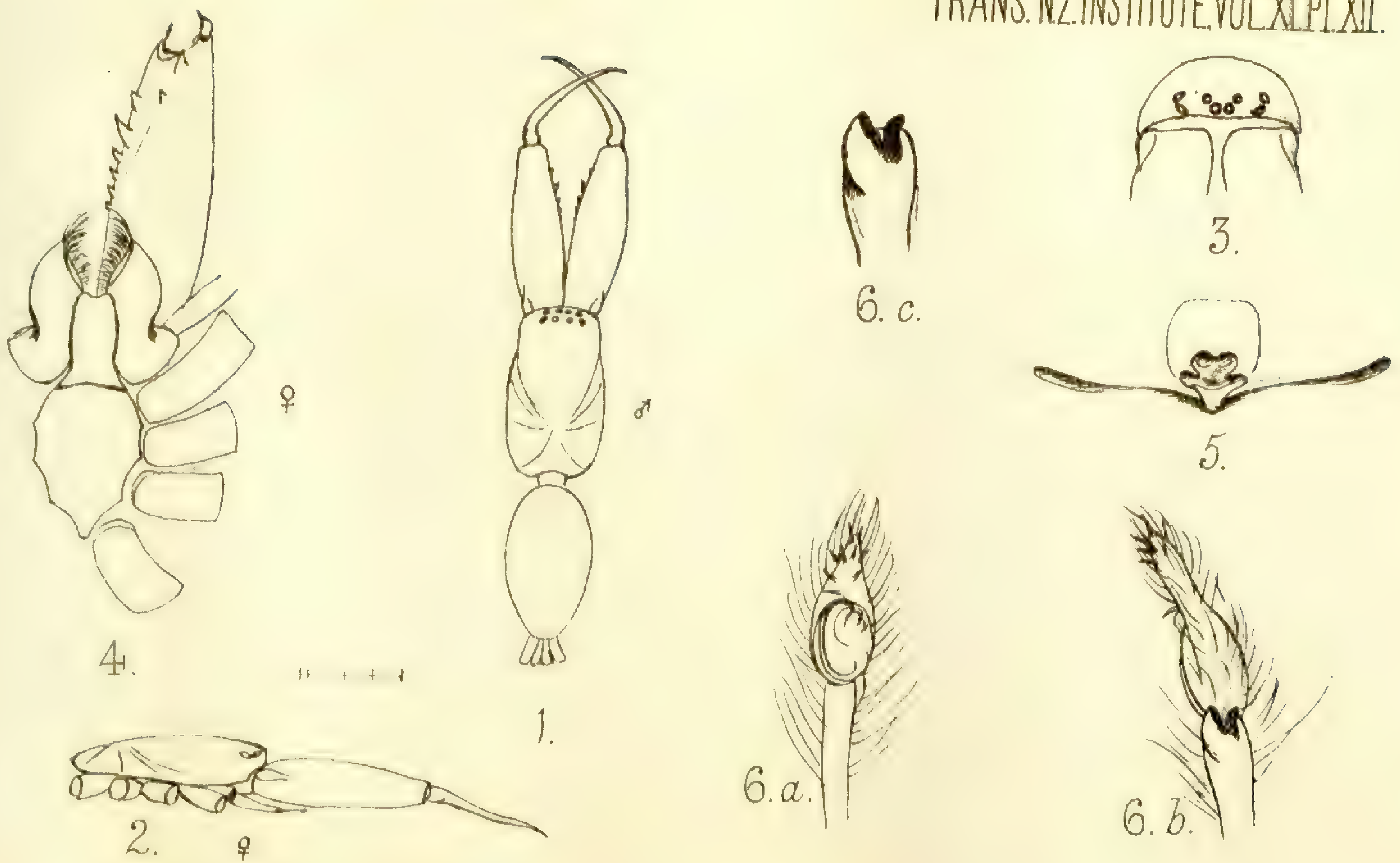
"The nests of this spider do not, in my opinion, occur below low water; but it is difficult to state positively. The mouth of the *Lithodomus* hole in which the nest is made is often, if not always, under low water in a tidal pool, and the nest is only to be got at by breaking up the rock with a heavy hammer. The spider, when going to the bottom of a pool, on being disturbed, does not take down an air-bubble so far as I could see, and is able to live a considerable time without air or only the small amount to be found in sea-water. I have kept them alive for several days in a bottle quite full. The cocoons of eggs are found at the end of the hole and always quite dry. I have not seen these spiders at any place but Cape Campbell, and there not far above low-water mark, there being many feet of water over the rocks in which they live at high tide."

Further observations on the habits of this spider are desirable. An examination of their nests might disclose the nature of their food. Also, if Mr. Robson is correct in stating that the mouths of the holes in which they live are always below low water, how are they supplied with air? A careful comparison of *Desis robsoni* with Koch's description and figures of *Desis martensii*, shows that these two spiders differ very slightly. The posterior pair of legs are much shorter relatively in *Desis robsoni*. The posterior row of eyes in *Desis martensii* are concave anteriorly, in *D. robsoni* very slightly concave posteriorly. The process on the radial joint of the male palpus differs in form in the two species, and there are only six teeth to the upper border of the fang groove in *Desis robsoni*, there being seven in *Desis martensii*. Walckenaer's diagnosis of the genus founded on a single species needs revision now that three more species have been discovered. The arrangement and relative proportionate size of the eyes and the length of the legs vary from the characters as laid down by him in the Histoire des Aptères.

DESCRIPTION OF PLATE XII.

Desis robsoni.

1. Male, showing form and relative proportions of cephalothorax and falces.
2. Lateral view to show elevation of cephalathorax, female.
3. Anterior view of caput showing arrangement of eyes.
4. Sternum, lip, maxillæ, and falx, female.
5. Epigyne, female.
6. Radial and digital joints of palpus, male, as from beneath, *b* from outer side, *c* extremity of radial joint.



DESIS ROBSONI.

ART. XXIII.—*Notes on the Anatomy of* Regalecus pacificus, *von Haast.*
By LLEWELLYN POWELL, M.D., F.L.S.

[*Read before the Philosophical Institute of Canterbury, 21st February*, 1878.]

DR. HAAST, in the description of *Regalecus pacificus*,* speaks of the silvery, or rather, to my eye, steely coating which contributes so greatly to the beauty of this splendid fish. It is impossible to reproduce it either in a drawing or to perpetuate it by any mode of preservation, as it is detached by the slightest touch, leaving a slimy, silvery patch on the finger. This coating has been described as consisting of minute scales by one observer, and by another as scales resembling those on a butterfly's wing. Such is not, however, the case. It is evidently a secretion similar to the slimy mucus which many other fishes secrete so copiously. The microscope resolves the steely layer into myriads of exceedingly minute crystalline needles, or elongated tabular prisms with oblique ends. The largest have a length of $\frac{1}{160}$ inch by $\frac{1}{3000}$ inch in breadth. These crystals show a beautiful metallic lustre, are not perishable, do not polarize light, are immediately dissolved in liq. potass., but are insoluble in strong acetic acid. I cannot ascertain the nature of the silvery coating found in the swim-bladder of certain fishes, such as *Atherina*, which was formerly used in the manufacture of artificial pearls. It is not improbably of a similar nature.

The scales of the lateral line are peculiarly formed, being very long in proportion to their breadth. Their length slightly exceeds $\frac{1}{2}$ inch, while their breadth does not exceed $\frac{1}{25}$ inch; one extremity is slightly expanded or spoon-shaped, the other extremity contracting abruptly to a point which articulates firmly with the dilated extremity of the following scale. These scales appear to me to be tubular, but I cannot be certain of this as they shrivelled in drying.

I noted a few points in the internal anatomy. I regret that as daylight was closing, and it was necessary from the extremely soft and watery nature of the integument and the flesh to use despatch in order to save the skin in good condition, I was unable to make a more thorough examination of this interesting fish.

The gullet terminated at 2ft. 7in. from the snout in a remarkably elongated muscular stomach, prolonged backward as a kind of cæcum to a length of 4ft. and about 2in., extending 2ft. 7in. beyond the vent in a diverticulum from the peritoneal cavity, and becoming narrower and more and more attenuated until it becomes so exceedingly thin and delicate that, with the utmost care in dissection, the extremity was torn and imperfect.

The pylorus was seated immediately by the side of the cardiac orifice, being provided with a strong muscular ring, the duodesma, if one may so

* Trans. N.Z. Inst. X., 246-250, pl. vii.

speak of the commencement of the intestine, passed directly forwards, plunged immediately into a cylindrical mass of densely packed pyloric pancreatic cæca. These were short, adherent to one another, and so closely massed that the intestine appeared to have no proper wall, appearing more like a broad glandular duct; on cutting into the pancreatic mass, a white chylous fluid exuded abundantly. The glandular mass was 15in. long by more than 3in. broad. At its extremity the thin-walled intestine emerged from the pancreatic mass and turned abruptly backwards, passing without any convolution to the vent. It was full of a gruelly fluid.

The stomach exhibited, in its anterior part, strong longitudinal muscular bundles becoming more and more attenuated as they proceeded backwards. It was empty, being merely coated with a layer of mucus, stained of a pinkish hue, with dark red particles here and there. A microscopic examination of this mucus made with the object of determining the nature of the food of this deep-sea fish, discovered myriads of minute conical calcareous bodies, some of them perforated longitudinally, having a very uniform size of about $\frac{1}{375}$ inch by $\frac{1}{1600}$ inch broad at the base. I do not know what these may be, but am inclined to think that they are the cutaneous species of some echinoderm.

The fish was a female, the ova exceedingly minute and undeveloped. A single oviduct, divided 12 inches anteriorly to the vent into two cylindrical ovaries, these ran forward to a point 17 inches posteriorly to the snout, the right being somewhat smaller than the left, they each terminated in a strong suspensary ligament.

The large liver, of a most beautiful vivid orange tint, weighed 4lb. 12½oz. It was cleft into two longitudinal lobes posteriorly; there was also some minor lobation, one smaller lobe overlapping the large gall bladder which was full of dirty watery fluid. The liver overlapped the pyloric mass which was entered by the ductus choledocus.

The kidneys had the usual situation and appearance; their length was 2ft. 6in. There was no swim-bladder, and of the dorsal bladders spoken of by Mr. Travers I need hardly say there was no trace. It is evident that the curious spaces left by the detachment of the strong longitudinal intermuscular septa were mistaken for bladders by that gentleman.

The skeleton consisted of the softest cartilage; it would have been a matter of the greatest difficulty to isolate and preserve it.

Art. XXIV.—*On the Brown Trout introduced into Otago.* By W. Arthur, C.E.

[*Read before the Otago Institute, 9th July*, 1878.]

Plate XIII.

The principal object of this paper is to put on record those facts which have been ascertained, connected with the acclimatization of trout in Otago. The present time is in many respects peculiarly suitable for observing how exotic plants and animals adapt themselves to the conditions of life in New Zealand, into which they have been recently introduced. It is equally true, and has been advocated before now, that observations constant and careful should be undertaken by all the friends of science, on the effects of colonization upon the native flora and fauna; because the existing circumstances under which these are placed are in a state of progression and change, while the old conditions will soon be things of the past. So also with our trout, for in twenty years hence the banks of many streams, which at present in a state of nature supply certain food, will be cultivated and probably yield a totally different description of food, while the trout themselves will be much more numerous and, I am afraid, of a smaller average weight. The opportunity can only occur once, of observing the immediate results of stocking any stream with trout. Therefore it seems to me a reasonable precaution to publish periodically an account of the progress of our knowledge, and as a contribution towards this object I have selected the special subject of this paper, being one in which I have always taken much interest.

1. *Distribution and Growth of Trout in Otago.*

The first successful hatching of trout (*Salmo fario*) in Otago was in October, 1868. This was achieved by Mr. Clifford, then Curator to our Acclimatization Society, who went to Tasmania, and got from the natural spawning-beds at the breeding-ponds of the Plenty, 800 ova, whereof 720 were hatched out as above at our Opoho breeding-ponds. Part of this lot was sent to Lake Wakatipu, but all the young fish died on the road. The remainder seem to have been sent to Mr. Young, at Palmerston, and were turned out in the mill-race on that gentleman's property. A year afterwards one of these fish was caught, and found to be seven inches in length. In October, 1869, the second shipment of 1,000 trout ova was brought from Tasmania by Mr. Clifford, and placed in the breeding-boxes at Opoho, the water having a temperature of 44° Fah. The fish from these two lots of trout ova form the original stock, which were liberated in our streams in November, 1869, and from these and their descendants the ova for stocking the rivers in Otago have been obtained. I append a table published by our Acclimatization Society, showing the rivers into which young trout

have been put, their number, and the years in which this was done. Altogether, 64,810 young trout have been liberated in 134 rivers and streams in Otago up to December, 1877.

As showing how soon and easily confusion may arise for want of a few precautions, I may here mention that beyond the general fact that our breed of trout is believed to be from a Thames tributary, we really do not know much about them. It is true that the trout in Tasmania, whence ours were brought here as their ova, were got from England, but what particular stream to trace them to seems from all I can learn to be now impossible. From notes kindly given me by Mr. Howard, of the Wallacetown salmon-ponds, it appears that three lots were sent to Tasmania, which turned out more or less successful. Of these, Mr. Francis Francis sent one from the Weycombe, Bucks, and another from the Wey at Alton, Hants, and Mr. Buckland sent one lot from Alresford, on the Itchen, Hants. If I am not able to say, therefore, to which place the descent of our trout is to be traced, or if each of the places named has not a joint honour in their parentage, I think you will agree that we have got a very handsome and valuable variety of *Salmo fario*.

Growth of the Trout.—I will now proceed to lay before you such facts as I have been able to collect, tending to show the probable rate of growth of trout in our rivers, under the conditions of the state of nature which existed when these fish were first turned out and which still hold good for most of our streams, and particularly that no trout are ever known to have previously inhabited these waters. The rivers that I shall refer to are the Shag, Water of Leith, Lee Stream, Deep Stream and Upper Taieri, not because we have not information of the success of trout in other streams, but because such information is as yet rather general and indefinite.

Shag River.—In the year 1868, young trout, 75 in number, appear to have been put in Mr. Young's mill-race at Palmerston, as already mentioned, and in 1869 there were 53 liberated in Shag River. The mill-race has communication with the river. After this, the first specimens I am aware of, caught in this river, are those taken in 1874, and which are now preserved in the Otago Museum. The male fish (one of these) was taken in June of that year, and weighed 14lbs. The female (the other) was taken in July, and weighed 16½lbs. Now, comparing the above dates, we find that the greatest *possible* age of these fish could not exceed six years. This indicates an average growth for the male fish of 2⅓lbs. a year, and of 2¾lbs. a year for the female. But I am inclined to believe that for the first year or eighteen months trout do not attain that average in our streams, or at all events in the Shag River. A certain amount of corroboration arises from the fact I have alluded to above, of Mr. Clifford catching one of the 1868

trout in 1869, and finding it measure seven inches, which would represent a weight under half a pound. If we say then that the above two trout attained a weight in the first year of even one pound, then their subsequent average growth must have been $2\frac{3}{8}$lbs. and $\frac{3}{10}$lbs. respectively, yearly.

Water of Leith.—In 1869 the first trout were put in this stream, 75 in number, and additions have from year to year been made to this and other rivers to keep up the stock. In the end of 1874 and beginning of 1875 the Leith was opened for angling, when the largest trout caught weighed 3lbs. In August, 1875, among a number of spawning fish taken, I saw one which must have weighed 7lbs. Mr. Deans, the curator of our Acclimatization Society, informs me of a male trout taken in the Leith, in 1877, which weighed $12\frac{1}{2}$lbs.; and in February of this year a gentleman caught a female, while fishing with artificial minnow, which weighed 10lbs. This latter fish I saw; it was a very well-shaped specimen and in excellent condition. It is certainly astonishing that trouts can attain such weights in so small a stream running through a city like Dunedin! The average yearly growth of the largest of these trout—viz., the male fish—is a little over $1\frac{1}{2}$lbs.—on the same supposition as I used regarding the Shag River fish—viz., that it was one of the fish put in in 1869. Any other theory will, of course, give a more rapid growth, but I do not consider it safe to err in that direction.

Lee Stream.—Trout were, to the number of 98, put into this (which has become the favourite angling stream of Otago) in the year 1869. No other lot of trout has ever been added, yet these 98 young fish have stocked the stream throughout its whole course of some twenty miles from near the Lammerlaw mountains to the Taieri River into which it flows. It was open for angling in 1875. In October of that year a well-known angler killed some very fine fish with fly. The heaviest of these weighed 5lbs.—this is equal to a yearly growth of $\frac{5}{6}$ of a lb., or say 1lb.

Deep Stream.—In 1869 there were 100 young trout turned out in this stream. This is the only lot ever put into the Deep Stream, where fish are now plentiful. It was opened for angling in 1875, but no fish over 2 to 4lbs. was taken till 1876, when one of 8lbs. was caught with grasshopper. This gives $1\frac{1}{3}$lbs. as the known yearly growth, on an average, of the trout in the Deep Stream.

Upper Taieri.—In 1870 a few dozen young trout were put into this river at the Styx, and in 1875 there were 425 more turned in. At the beginning of this year it was fished for the first time, when several large trout were taken, weighing from 3 to 6lbs., the largest which was caught with the fly being 6lbs. 6ozs. in weight. This gives the greatest possible yearly growth at 13 ozs., or say 1lb.

Of other streams we have not so much information; but I may mention that large trout have been seen in the Kakanui, Waitati, Lovell's Creek,

Fulton's Creek, Waipahu River, Mimihau, and some of about 10lbs. in weight in the Wakatipu Lake at Queenstown. In the Kuriwao a trout 6½lbs. was killed in the beginning of this year. Trout were first put in this stream in 1874, but into the Waiwera, into which the Kuriwao runs, in 1873. So that the average yearly growth may be taken at about 1½lbs. As regards the Waikouaiti River, I have had, from two different sources, tolerably reliable evidence that the trout put into it have lived and thrived, but this requires confirmation.

In the above I have, as explained, regarded the average weight on the theory (which is a safe one), that the fish actually caught and weighed, may have been individuals of the first stock put into each stream. Of course there still remains another, but more laborious, method for the future, of determining the rate of growth, viz., marking young fish when caught, and returning them to the river for future observations. Two summers ago I began this plan in the Lee Stream, by removing the posterior half of the adipose fin; but as yet I have not been fortunate enough to recapture any of those so marked. These fish would run from four to seven inches in length, and in number about one dozen. In the Southland rivers young trout were turned out from 1870 to 1877, as shown by a list appended, which Mr. Howard has sent me. As yet, however, I have not been able to get any positive information as to how they have succeeded.

Comparing now the growth of our trout with river trout of England and Scotland, I find that Stoddart, in his Lochs and Rivers of Scotland, gives the following as his opinion. The fry are hatched out in April, and by the month of October stop growing for that season, having attained a length of six or seven inches, and weighing a quarter of a pound. There is no perceptible growth till the following spring, when food again becomes plentiful. They then resume growing, and before winter have increased in length by two inches, and in weight up to half a pound, by which time a certain number are in spawning condition. It is four years before these fish reach one pound weight, when many cease growing, but some from favouring conditions of locality and feed reach a greater weight. These latter live almost entirely upon ground and surface food—not minnows. In well sheltered waters and when the feed is particularly good, as in the Leet and Eden, in the course of five or six years trout have reached two pounds weight and upwards.* Again, Yarrel, in his British Fishes, says:—"An acutely observing friend of mine * * * has for years kept trout in a kind of store stream, and having fed them with every kind of food, has had some of them increase

* Stoddart says that in South of England an experiment with trout in three tanks fed respectively with worms, minnows, and large water-flies, was tried, when those fed on flies attained twice the weight of the others.

from 1lb. to 10lbs. in four years. I found, says he, that one of the trout I had fed and weighed regularly for the last six years was not improving in size and colour. I therefore killed it. The fish is a female and weighed exactly seven pounds. The accompanying schedule will show its gradual increase:—

Date of weighing	1835	1836	1837	1838	1839	1840
	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
April 1st.	0 12	1 12	3 4	5 4	7 0	7 4
October 1st.	1 4	2 0	5 0	5 12	7 8	7 0

Littlecot, October, 1840." This latter experiment shows, under careful artificial feeding, that trout are capable in England of a growth, according to this gentleman, of 1⅗ lbs. yearly to 2½lbs. when they have reached their full growth. But trout, in a state of nature, as described by Stoddart, may more properly be compared with the results I have given of our Otago trout. Stoddart's remarks therefore amount to this, that under the most favourable circumstances at home, river trout will attain up to maturity, a yearly average increase in weight of ⅓lb., while our experience here shows they have reached an average yearly increase of from 1lb to 2¾lbs! In no river of Otago have these fish grown so rapidly, are so fat, or have become so heavy as in the Shag, some individuals having been seen in Mr. Rich's property supposed to be 20lbs in weight. They abound from the estuary to the "second gorge," a distance I should think of 15 miles by the river. The banks of the Shag are partly cultivated and partly covered with native grass and flax. Surface food cannot therefore be plentiful, but at all seasons there are in the pools and shallows numbers of *Galaxias* or native minnows, bullheads, and during summer immense shoals of smelts and silverfish.* On one occasion I killed a trout below Palmerston, 6½lbs. weight, in the stomach of which I found about three dozen smelts. It is rather against the trout, that during summer the Shag River runs low and clear, so low as to be easily crossed in the fords with watertight boots without the feet getting wet. The growth of trout in the Leith may also be attributed chiefly to the great numbers of smelt which frequent its lower waters. But it is different with the Lee, Deep Stream, and Upper Taieri rivers, where the great staple of food is made up of flies, gnats, grasshoppers, cadis-bait, fresh-water shell-fish, beetles and cray-fish—the small kinds of native fish are not very numerous in these streams. Before leaving this part of my subject, I may mention a curious circumstance regarding the Lee Stream which anglers have discovered. Painfully lean trout have been caught there, which took the fly or grasshopper greedily

* This fish is called Silverfish by Mr. Powell, but Smelt (*Retropinna richardsoni*) by Dr. Hector; it is a true salmonoid, which the fish I have called a smelt is not, but is also known as whitebait.

and were apparently in good enough health. In December, 1875, I killed one of these which, though about 24 inches in length, only weighed 4lbs. It ought if in good condition to have been about 7 lbs. Several other similar or worse-conditioned trout have since then been taken. But the worst specimen I have seen was caught at the beginning of this year, in a feeder of the Lee, the Broad Creek, which surpassed all others in its poverty. It was about twenty inches long and weighed only 1lb. or thereby. There was really no substance on its body, it was literally a skeleton. It is difficult to account for such a phenomenon, particularly when equally large trout have been killed in the Lee, which were in excellent condition.

2. *Habits of the Trout.*

In dealing with this part of my subject, I propose to offer a few remarks under the heads of Spawning Season, Differences of External Appearance, and the Habits of our Trout as observed during the open season.

Spawning Season.—From actual observations, trout are known to have spawned in the several streams named as follows:—

Shag River	from June 20th	to July 31st
Water of Leith	„ June 30th	„ Aug. 4th
Lee Stream	„ June 15th	„ July 25th
Lovell's Creek	„ June 6th	„ July 31st
Fulton's Creek		during July, &c.

In Silverstream, a man of Mr. McGregor's saw trout engaged, as he thought, spawning from June 20th to July 20th.* As regards Southland, propagation of trout has been carried on there solely with fish kept constantly confined to small ponds at Wallacetown by or under charge of Mr. Howard. This gentleman's experience of this method has proved it to be a mistake. Spawning is late and prolonged and the breeding fish do not thrive. He found that they lived well enough throughout the year, but were liable to attacks of fungus, which killed them in fourteen days. This fungus he cured repeatedly by washing or dipping the fish in salt water; but it invariably returned, and eventually the trout succumbed. With us, Mr. Deans has followed a more natural plan, that of catching the fish when ripe, stripping the females of their ova, and impregnating these with the milt of the male. The milt of young or mature males does equally well, and one male is sufficient to fructify the ova of several females. The trout in the Leith will average 800 ova to the lb. weight of the fish itself. A female ½lb. weight has yielded about 400, and one of the largest caught, being a healthy fish of about 7lbs., gave close on 6000 ova. In our breeding boxes at Opoho, we have found the time the ova take to hatch to be 78 days; but this is modified to some

* This period is later than the corresponding time at home, which is in October and November, by about six weeks.

extent by the temperature of the water. During the winter months the temperature of the water averages about 42°F.; and during the period of hatching it ranges from 42° to 52°. The strongest and healthiest fish are those which are hatched out in water at 48°. After birth the young trout are ready for turning out in from 30 to 50 days, but will carry best whenever they begin to feed, which is at an age of 25 to 28 days. When the young fish are about 6 weeks old and well fed, they average, in our ponds, 1½ inches in length, and at 100 days measure 3 inches, being distinguished by dark bands like the fry of the salmon. In transporting the trout fry from the ponds to the rivers in which they are liberated, it has been most successfully done with fish about 1 inch to 1½ inches long. the can of water having a sufficient quantity of watercress put into it carefully to prevent the consequences of shaking in transit. In this manner Mr. Deans has conveyed many supplies to our streams without losing a single trout. It has been observed with us, that in spawning, when the female has selected her male companion, she proceeds to a suitable gravel bed, where she prepares the ridd with her tail, the action of the stream assisting. She frequently rolls on her side and lashes the water with her tail, the ova being passed and impregnated from time to time, until the whole operation is completed. When confined they have been seen to take 8 to 10 days or more in spawning; but as yet I have not ascertained how long they naturally take in our rivers; probably, however, not more than a week.

Differences in External Appearance.—The differences in the external appearance of our trout are corroborative of all previous experience of these fish in home waters. Here, as there, these are due to various causes, such as age, sex, abundance or scarcity and also quality of food, range and colour of water, geological character of formation over which the river flows, and the season of the year. My own observations here, enable me to say that our trout are finest in appearances at the height of summer. By autumn they begin to get darker, some even I have caught were black-looking and lean, though all originally from the same stock. Already the various streams have stamped the trout with local peculiarities of some interest. Thus for example, in summer, trout which I have seen taken out of *Shag River* were remarkable for plumpness and good condition almost to deformity. They were all very bright silvery on the sides running into pure white on the belly, the back being grey or very light olive. Spots sometimes numerous and mostly of large size and black in colour, red spots are awanting or rare. The heads are small, even in the males, those of the females being beautifully shaped. The extreme fatness of form and bright silvery colour, I have no doubt are due to the river bottom being fine sand and gravel, the water clear, and the great bulk of the food being the small

fish already mentioned. This agrees with the opinion expressed by Sir Humphrey Davy, as mentioned in Dr. Hamilton's British Fishes, which is, that when trout "feed much on hard substances, such as larvæ and their cases, and the ova of other fish, they have more red spots and redder fins, and that when they feed most on small fish and on flies, they have more tendency to be spotted with small black spots and are generally more silvery."

In the *Water of Leith*, when first opened for fishing, the trout were of a fine appearance, colours being bright and the red spots large, but there is a falling off in this respect, at least as regards average-sized fish, and during spawning they all assume a darker or greyish hue. This water flows through bush, and its bed is one mass of trap rock, boulders, and small stones. No doubt a large amount of the feed is in flies, caterpillars, and slugs, and also, in the lower pools, smelts.

The trout in the *Lee Stream* also, when it was opened for fishing in 1875, were, as a rule, of a handsomer shape and colour than they now are. The females, of 2 lbs. and upwards, were silvery on their sides, very fat, and had small well-formed heads, a few red spots also along the sides. The males were dark olive brown on the back, golden yellow on the sides, and pure white on the belly. They had, and still have, numerous black spots, and large red or crimson spots on the sides and below the lateral line. The adipose fin in these and the trout in the other rivers is tinged with red, and is distinguished by two or three dark brown spots. The tail also has a few dark spots, generally confined to the upper margin. The males in this stream, when in good condition, are very handsome fish, the head though large is not unusually so. The bed of this river is mostly rocky, but in the upper water it is more gravelly than below the Accommodation House. Some of the pools towards the end of summer get very much overgrown with water plants. The feed consists of the native life from the tussock-covered banks, flies, beetles, spiders, and numerous grasshoppers, while the bed of the stream contains small shell-fish, larvæ, and crayfish. The native minnows and small fish are not plentiful. The Lee rises near the Lammerlaws, at a height of about 1,500 feet above the sea, and joins the Taieri River at about 40 feet.

The *Deep Stream* trout have a tendency to be more silvery in colour than those of the Lee. Still, the males are very much alike, with numerous large black spots, the usual number of large red ones, and a rich golden tinge over their sides. In February of this year I saw three very fine trout caught by Mr. Pillans in the Deep Stream, with minnow. In weight they were from 2¼lbs. to 2¾lbs.; they were females. Two of them were olive brown on back, silvery on sides and belly, the spots large and dark, but not

numerous, and a few red ones as usual. The third fish differed in a marked degree from these, though all three were fat and in good condition. Its back was olive colour like the others, but its sides were of that rich golden hue, so pleasing in an angler's eyes, while the black spots were exceedingly numerous, only about an eighth of an inch apart. I have not in New Zealand seen another case of such a difference in external colour and markings in trout of the same sex taken under such exactly similar conditions. In waters I have fished in Scotland, however, I must admit I have seen more remarkable differences, and where least to be expected. The character of the bed of this stream is generally rocky, but it has many more gravel-beds than the Lee, particularly for two miles above and below Walsh's Accommodation House, where anglers usually put up. The banks of the stream, like those of the Lee, are all in a state of nature—all native tussocks and rushes, with a few veronicas in places—the feed also is the same. In its course from the Lammerlaws to the Taieri, it will cover a distance of 30 or 40 miles, and, being snow-fed in early summer, is rather later as an angling stream than the Lee.

As regards the *Upper Taieri*, the fish, so far as I have seen them, are similar to those of the two last streams described; but my acquaintance is as yet too limited with the trout there, to warrant me saying more about them as to appearance. The capabilities of this river for producing large well-conditioned trout, consist in the immense ranges of water, or reaches, free from any obstructions which characterise it, and a considerable supply of bottom feed, abundance of insect life, and rich loamy banks. The course of the stream is also marked by abundance of gravel, suited for spawning beds.

In no stream here have I as yet seen trout of mature size, marked with distinct bands of dark colour transversely to the length of their bodies. This is a common mark in British streams, but the colour is evanescent, and will disappear in a short time if a trout goes under a stone or bank. When fishing clear reaches of water at home, I have frequently noticed this peculiarity. These bands are only assumed by the fish when the river is clear. I have never seen them when the water was discoloured, nor in lake fish. It is well known at the same time that trout can alter their colour to suit that of the water for the time being; they are much lighter when the water is clear than during floods.

3. *Habits of the Trout, as observed by Anglers.*

Undoubtedly the trout here are more bold, when feeding, than at home, possibly because as yet our streams are not so much fished.* The time

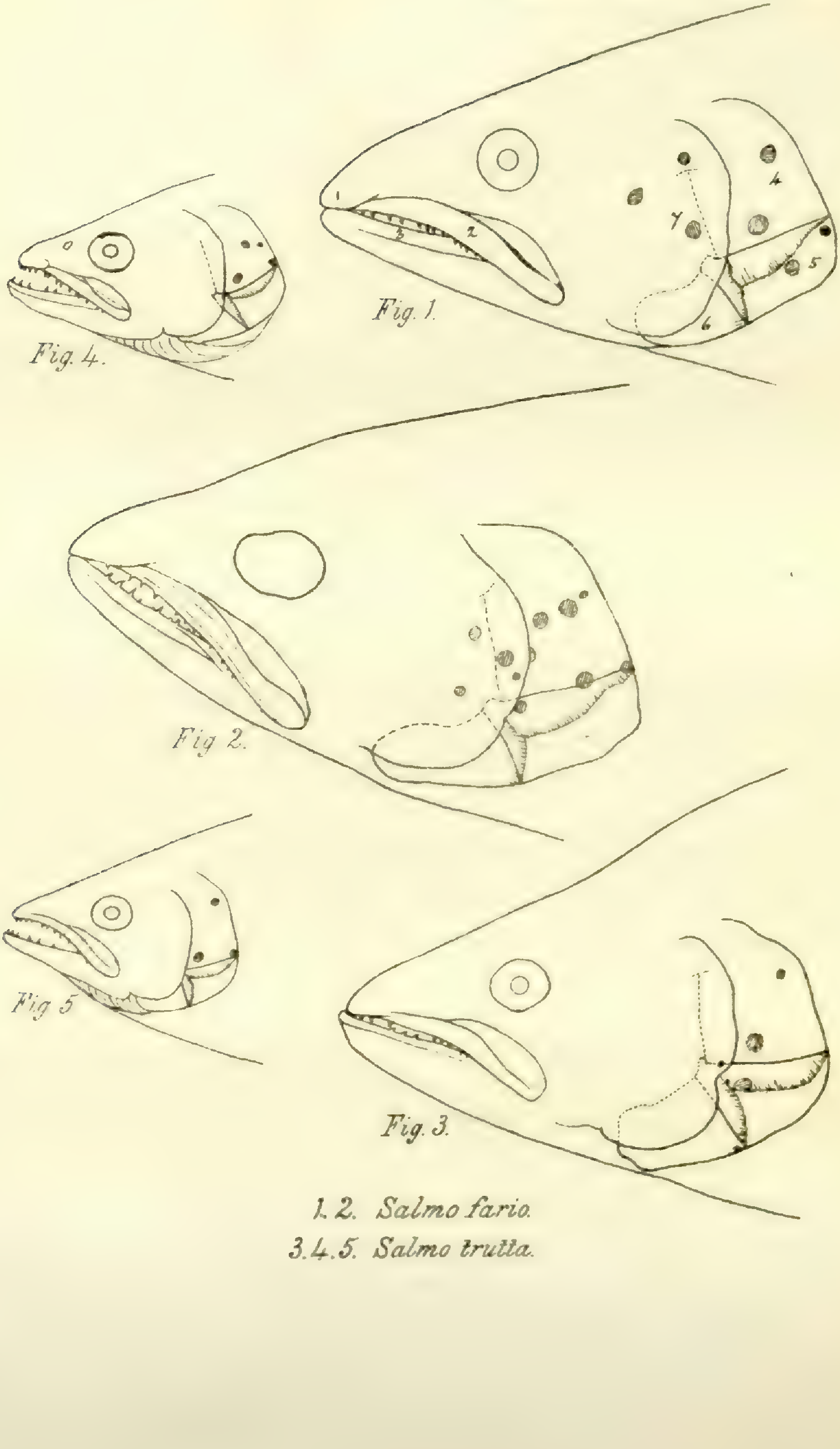
* They always feed with their heads up stream, seize their prey by the head, and bolt it or suck it into the gullet.

of day also when they appear to feed most, differs in some of our waters fished by me from all previous experience. Thus in the Lee and Deep Streams, every angler has remarked that they are more on the feed during the middle of the day, from spring to autumn, than either in the morning or evening;* while in the Shag River and Leith they are found to feed when the water is low and clear, almost entirely at night. In the Shag River, there can be no doubt, this is owing to the fineness and transparency of the water. There, during the day, a few fish only are seen; but from dusk, all through the night until dawn, they are more or less on the move, while at times the water seems alive with large fish, which throw themselves out of the water, tumble along the surface, or pursue the whitebait and minnows right into the shallows. Then is the time when the fish are nearly all caught, that being done by the use of natural or artificial minnows. A fresh in this river operates similarly to nightfall, and large takes have been often made on such an occasion. In the Leith good fishings have been got in the morning, but the best at night.†

In all these streams of Otago the meteorological conditions of the atmosphere seem to have a marked effect on the movements of the trout. Thus, with a falling barometer and the approach of rain, particularly if the air is at the same time getting colder, I have noticed that the trout invariably cease feeding. It is only rarely I have caught trout, and never more than a solitary one, under these circumstances. Electricity also, when approaching in the form of thunder clouds or otherwise, has the same effect. But when the storm actually bursts over the stream, as a rule I have found the fish begin to take once more. I have seen the very same thing occur on Scotch waters. As a rule here, it is found far more trout are caught when an east wind blows than when it comes from any other direction; the temperature of this favourable wind has a good deal to do with this result. Although no experiments as yet have been made here to test the theory, yet I believe that, as regards temperature, trout will take surface food as long as the air is warmer than the water, and at times when colder, but only within certain limits. Not only do my own observations lead to this conclusion, but I may mention here a corroborative fact which came to my knowledge some years ago. Then being in Scotland, I had the good fortune to be permitted the perusal of a register of the temperature of the air and water at Loch Tay, which was shown me by a gentleman who had been residing there as factor to the Earl of Breadalbane, to whom the fishings belong. By comparing the readings of the thermometers for air

* I have killed good fish in the morning on one or two occasions, but rarely any fish at all at night, and never large ones.

† In British rivers, under ordinary weather, evening and night are the times when trout feed most, unless in spring, when this is confined to the middle of the day.



1. 2. *Salmo fario.*
3. 4. 5. *Salmo trutta.*

and water during each day of the fishing season, it was found that most salmon were killed with the rod on Loch Tay when the difference in temperature did not exceed 2° Fah.; but when it became as much as 5°, the fish ceased to take altogether. Although fish are cold-blooded animals, this would appear to indicate a certain degree of sensitiveness to variations in temperature. It is not so easy to account for trout and other species of the Salmonidæ being aware (to use a common expression) when the barometer is falling before rain, as I have stated already. But one thing I am convinced of is that they do feel when the atmospheric pressure on the water alters to an appreciable extent. They get sluggish, and will not move to feed when the air becomes rarefied. But when the weather begins to change and clear up they soon move about again and resume feeding. I explain this on the supposition that, in the first instance, the fish feel their bodies sensibly heavier, so as to indispose them to move; but when the atmosphere regains its normal pressure, they are relieved from the sensation of weight, and their ordinary lively habits are resumed. Other animals—human beings included—are affected by the very same cause. This is, no doubt, rather a speculative part of my subject, and I could easily enlarge my remarks on it, but probably I have said enough for the present.

4. Distinguishing Marks of Trout.

This brings me to the concluding and more technical portion of my paper, but before going into that I think it will be better to record my examinations of a number of specimens of *S. fario*, which were caught in some of those rivers which I have already frequently referred to. From various causes my notes are not so complete as they should be, but still I give them just as they are. They may be useful for comparison and reference.

Specimens of Salmo fario *examined in Otago.*

a.—1877, Nov. 30th.—Male trout caught in Lee Stream—the gorge water—with grasshopper, the river being very low. Condition thin, head long, and lower jaw hooked; colour, brown on back, golden on sides, numerous black spots and large red ones, a few being beneath the lateral line.

Dimensions: Weight, 5lbs.; length, 25 in.; depth, 6 in.; head, 6½ in.; maxillary bone projecting ½ in. behind the vertical from posterior margin of orbit; sixteen round black spots on gill-cover, one side. Teeth, vomer three firm five loose, palatines each well armed with teeth, tongue also, and with two small teeth loose near the tip.

Fin Rays: P.14 on each fin; C.21 (doubtful). *Scales:* 16 in transverse row from adipose fin backwards to lateral line. *Pyl. cæca*: 54. *Contents of stomach*: crayfish, 2 in. long, and remains of larger one; three legs of a grasshopper and part of a black beetle.

b.—Dec. 7th.—Male trout, taken at night in Shag River with natural minnow, water very low; colour silvery white, back light olive, spots black and numerous; condition very fat; head ordinary size, lower jaw hooked, maxillary projecting ¼ in. behind posterior margin of orbit; body of vomer, 5 teeth firm, 2 awanting; palatine left, 13 firm, 3 gone; right palatine, 10 firm, 4 gone.

Dimensions: Weight, 5 lbs. 2 oz.; length, 23 in.; depth, 5½ in.; girth, 13½in.; head, 5½ in.

Fin Rays: P.13 on each. *Scales:* 15 on one side, 16 on other, in transverse rows from dead fin backwards to lateral line. *Pyl. cæca:* 43. *Contents of stomach:* remains of one or two small minnows.

c.—Dec. 19th.—Male trout, taken in Shag River at night with natural minnow; water low; colour, silvery sides, back, light olive; spots black and numerous, some on upper margin of tail, lower margin gone, probably bitten off by a shag; condition fat; head ordinary size, lower jaw hooked, maxillary projecting ½ in. behind the posterior margin of orbit; head of vomer, 3 teeth; palatine a row each. *Dimensions:* Weight, 5 lbs. 5 oz.; length, 23½ in.; depth, 6 in.; girth, 13½ in.; head, 6 in.

Fin Rays: D.13, P.$\frac{13}{14}$ $\frac{\text{one side,}}{\text{other side,}}$ V.9, A.12, C.22. *Scales:* 14 in transverse row from adipose fin backwards to lateral line. *Pyl. cæca:* (not taken). *Contents of stomach:* part of one small minnow.

d.—1878, Jan. 19th.—Female trout taken with grasshopper in Lee Stream in the Ledge pool; colour, back brown, sides olive colour, belly white, black spots plentiful, red ones very large; tail slightly forked; head small, maxillary within vertical from posterior margin of orbit; head of vomer, 2 teeth and 2 gone; body of vomer, double row; palatines, one row of teeth on each.

Dimensions: Weight, 2 lbs.; length, 16 in.; depth, 3½ in.; girth, 8½ in.; head, 3¼ in.

Fin Rays: D.13, P.14, V.9, A.11, C.19. *Scales:* 15 in transverse row from adipose fin backwards to lateral line. *Pyl. cæca:* 54. *Contents of stomach:* shell-fish and cadis-bait numerous, leg of crayfish, two small stones.

e.—Feb. 8th.—Male trout caught in Deep Stream with grasshopper; water low and clear; colour, back brown, sides and belly, golden tinge, black spots very numerous and large, red spots large, a few black spots on adipose fin and upper margin of tail; head ordinary size, maxillary projecting ½ in. behind vertical from posterior margin of orbit; head of vomer, 3 teeth and 1 gone; body of vomer, double row, some missing; palatines, 1 row on each.

Dimensions: Weight, 3¼lbs.; length, 19 in.; depth, 5 in.; girth, 11¼ in.; head, 4¼ in.

Fin Rays: D.11, P.12, V.9, A.10. *Scales:* 15 in transverse row, from adipose fin backwards to lateral line. *Pyl. cæca:* 46. *Contents of stomach:* crayfish, beetles, flies.

f.—Feb. 8th.—Female trout taken in Deep Stream, with grasshopper. Colour, back olive brown, silvery towards belly, black spots ordinary number and large, red ones not very distinct, on gill-cover six distinct large black spots; head small; maxillary projecting ⅛ in. behind vertical from posterior margin of orbit; teeth, double row on vomer, some awanting; one row on each palatine bone. This fish was in excellent condition; roe well developed. When cooked was found of first-rate quality; the flesh was very red.

Dimensions: Weight, 4 lbs. 10 oz.; length, 22 in.; depth, 5 in.; girth, 12¼ in.; head, 4½ in.

Fin Rays: D.13, P.12, V.9, A.11. *Scales:* 17 in transverse row from adipose fin backwards to lateral line. *Pyl. cæca*: 47. *Contents of stomach:* crayfish, green beetles, and flies.

g.—March 2nd.—Female trout, taken in Broad Creek, with grasshopper. Colour, back olive brown, sides and belly silvery, black spots ordinary number, red ditto all large; six black spots on left side of head and five on right; tail large, forked and handsomely shaped; it and adipose without spots; head very small; right maxillary projecting ⅛ in. behind vertical from posterior margin of orbit; left maxillary awanting, excepting small portion of posterior end, evidently lost by some accident; fish fat and in good condition.

Dimensions: Weight, 2¼ lbs.; length, 17¾ in.; depth, 4⅜ in.; girth, 10¾ in.; head, 3½ in.

Fin Rays: D.13, P.13, V.9, A.10, C.19. *Scales:* 16 in row from adipose fin backwards to lateral line. *Pyl. cæca*: 47, surrounded by unusual quantity of fat. *Contents of stomach:* cadis-bait, larvæ, grass, rushes, and one small shell-fish.

h.—March 6th.—Male trout taken in Shag River at night with natural minnow. Colour, back light olive, sides and belly silvery, black spots numerous and large, no red ones, black spots on adipose fin but none on tail, tail square; head small, maxillary projecting ¼in. behind vertical from posterior margin of orbit; fish fat, short and thick, back arched; teeth, two on head and usual rows on body of vomer and on palatine.

Dimensions: Weight, 5¾lbs.; length, 21¾in.; depth, 6in.; girth, 14¼in.; head, 4¾in.

Fin Rays: D.11, P.13, V.10, A.10, C.19. *Scales:* 16 in transverse row from adipose fin back to lateral line. *Pyl. cæca:* 47, doubtful number, some being cut in removing stomach. *Contents of stomach:* not examined.

The following two specimens described are the stuffed ones in the Otago Museum already referred to under the heading Distribution and Growth of Trout, and the natural colours of which cannot now be given.

i.—Male trout taken in Shag River, June, 1874. Present colour brown on back and dark grey on sides; head large; mandible terminating in very long hook; tail square; black spots numerous.

Dimensions: Weight, 14lbs.; length, $29\frac{6}{8}$in.; depth, 7in.; head, 7in.

Fin Rays: D.10, P.13, V.9, A.10, C.19.

Scales: 15 in transverse row from adipose fin back to lateral line.

j.—Female trout, taken in Shag River, July, 1874. Present colour brown on back and dark grey on sides; head short and blunt; tail square; black spots plentiful but not numerous.

Dimensions: Weight, $16\frac{1}{2}$lbs.; length, $29\frac{6}{8}$in.; depth, $6\frac{5}{8}$ in.; head, $5\frac{1}{4}$in.;

Fin Rays: D.11, P.13, V.9, A.10, C.19. *Scales:* 16 in transverse row from adipose fin backwards to lateral line.

Collecting now the results together of my examination of the various specimens above detailed, I find, that as regards the colour and spots, these vary in the different rivers from which the respective individuals were taken. The Shag River fish are all silvery, and, as a rule, have numerous black spots, red spots awanting or rare. The other trout, furthest removed in appearance from these, are those of the Lee and Deep Streams, which are golden on the sides; in the males black spots numerous; the females are mostly silvery, the spots being less plentiful, and both have red spots, the male most. The fin rays vary more or less; they are in the specimens examined by me dorsal, 10 to 13; pectoral, 12 to 14; V. 9 to 10, A.10 to 12, C.19. Of these, the most constant is the caudal fin, which never seems to vary from 19. In two specimens where I found more than this number, I am inclined to think I must have made a mistake in counting them. Next in invariability are the ventrals; seven individuals I found had each 9 rays in these fins, and only one had 10. The anal fin rays are tolerably constant, but the pectoral and dorsal fins vary a good deal.

The scales I found, reckoning from the adipose fin backwards to the lateral line, to range from 14 to 17, and the pyloric cæca from 43 to 54.* Now, if we compare these results with the numbers given by three authorities, Günther, Hamilton, and Yarrell, we find they give the following:—D.13 to 14, P.14., V.9., A.11 to 12, C.19, scales 15, and pyloric cæca, 33 to 46. That is, with the exception of the ventral and caudal fins, a higher number of fin rays than I find; scales fewer in a

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* The head of vomer carries 2 to 4 teeth, and body of vomer teeth all the way. Palatines, tongue, and mandible all armed with teeth.

transverse row, according to Günther, and the pyloric cæca fewer on an average by 9. As yet, I have made no examination of the number of vertebræ, so my comparison in that and one or two other particulars is incomplete.

With regard to the features of the head, as to structure, my remarks will refer to two heads, both of females—one of a fish, 4½lbs. in weight, taken in the Lee in October, 1877; and the other of a fish over 6lbs. in weight, caught in the Upper Taieri River in March, 1878. Fac-similes* of these are represented on pl. XIII., fig. 1 and fig. 2 *(S. fario)* accompanying this paper. In fig. 1 the posterior end of maxillary is $2\frac{9}{16}$ inches from the snout, and at its greatest width measures $\frac{7}{16}$ of an inch. The lower limb is strong and prominent, and the whole bone characteristically coarse and large.† Of the gill-covers, the posterior margin of the operculum forms nearly a right-angle with the junction line of the operculum and suboperculum. This junction or joint of the operculum and suboperculum forms an angle of nearly 23° with the axis of the body of the fish. The suboperculum in shape roughly resembles or approaches a rectangle, the posterior lower margin forming a blunt rounded angle. The average length, or middle length of this bone, is $1\frac{3}{16}$ inches, and the middle width $\frac{5}{8}$ of an inch. The interoperculum forms rather less than a right angle at its junction with the suboperculum, this line making with the axis of the body of the fish an angle of 47°. The lower margin is flatly rounded and continuous, nearly in line with lower margin of suboperculum, and the anterior extremity nearly semi-circular. The preoperculum is sinuously rounded in margin, and covers about one half of the surface of the interoperculum.

In the case of fig. 2, the posterior end of maxillary measures $2\frac{13}{16}$ inches from the snout, and the body of the bone very nearly ½ an inch at its greatest width. It is approximately similar to the maxillary of fig. 1, the Lee Stream trout, only the posterior extremity is much more rounded, this fish being evidently an older individual. The end projects $\frac{3}{16}$ in. behind vertical, from posterior margin of orbit. The posterior margin of the operculum forms nearly a right-angle with the junction of the operculum and suboperculum. This line or joint of operculum and suboperculum forms an angle with the axis of the body of the fish of nearly 26°. The suboperculum in shape roughly approaches a four-sided figure, almost a rectangle, the posterior lower margin forming a blunt angle with a sharp curve at the apex. The middle length of this bone is $1\frac{5}{16}$ inches, and its middle width $\frac{6}{8}$ inch. The interoperculum forms at its junction with the

* [Reduced one-half from author's original drawings.]

† It projects $\frac{5}{16}$ in. behind the vertical, from posterior margin of orbit.

suboperculum rather less than a right-angle, this line of junction making with the axis of the fish an angle of 50°. The lower margin is flatly rounded, and is a general continuation of lower margin of suboperculum. The anterior end is semi-circular, or nearly so. The preoperculum has its margin rounded, and not so sinuous as in that of fig. 1; it covers fully the half surface of interoperculum.

The gill-covers, when examined from the outside, appear to be divided as shown by hatched lines on the diagrams, which traverse the body of the suboperculum. These lines, however, are only the margin of an integument or skin, covering a series of spines. They do not represent the true articulation of the bones, which can only be correctly seen by dividing the head in two, and examining the gill-covers from the inside. When this is done there is no difficulty, as the joints are marked by distinct ridges or lines of thickened bone. Dr. Günther lays some stress on the presence or absence of a lower limb to the preoperculum in salmonoids, and says of that of *S. fario*, it "is without or with a very indistinct lower limb." At the same time he makes no reference to the interoperculum, so far as I have been able to find. Now the lower limb referred to is not by any means a very distinct mark, but the interoperculum is a well-defined bone. There is only one general remark I need add here, which is, that the specimens of trout from our Otago stock examined are representatives of only one variety, while those available to the authorities I have named are of many varieties.

As an article of food, when our trout are taken from 2lbs. to 5lbs., in good condition, and at the proper season, they cut up pink or red, and if properly cooked are excellent. Those from the Lee and Deep Stream are the best I have eaten. The Shag River fish are rather earthy in taste, but this flavour almost disappears if they be cut across in thin steaks and fried.

Salmo trutta.

Having now concluded all I have to communicate for the present of the growth, habits, and characteristics of our brown trout, I should like, before closing this paper, to give you, for comparison, the results of such limited observations as I have been enabled to make on the sea trout (*S. trutta*) introduced into Otago. In 1871, Mr. Young, of Palmerston, put 134 young sea trout into Shag River. In November, 1875, a fish 10½lbs. weight was netted near Quarantine Island, Otago Harbour, which was declared on good authority to be a true sea trout. I saw this fish, and have no doubt as to its identity, though I had no opportunity of making an examination. Since then they have been taken in the salt water, in the harbour at Blueskin and at Moeraki, but not as yet in any river. A considerable number of these I saw; they ranged in weight from 1 lb. to 15 lbs., and I believe them to have been sea trout. As this is questioned, however, by some, I have

made diagrams of the heads of three sea trout (being the only ones I can get), two of which are at present in my possession, and one belongs to our Museum. They were caught in Otago harbour.

These are placed beside the diagrams of *S. fario* to facilitate comparison. By this means some characteristic distinctions are at once apparent. In each head the lower jaw is rather longer than the upper. The maxillary does not project beyond a vertical line drawn from the posterior margin of orbit. The lower limb is narrower and the upper broader relatively than in the two heads of *S. fario*, and the whole bone is finer and more delicate. Of the gill-covers, the greatest difference is manifest in the suboperculum, which roughly approaches a sector of a circle in outline, its lower free margin being nearly semi-circular. The outline of integument on surface of this bone has a great similarity in the three specimens, and differs decidedly from that on the same bone on the trout heads. The spots on the gill-covers are from three to four, while in the trout they are from seven to eleven; while of the more general features the heads are short and deep, and fine at the snout, that of the Museum specimen being only one-fifth of the whole length of the fish. This fish measures—length, 16 in.; depth, $3\frac{3}{4}$ in.; head, $2\frac{3}{4}$ in.; and scales 16 in transverse row from adipose fin backwards. And lastly, these three fish have the distinct coating of bright silvery scales all over their bodies. The description of the head (*S. trutta*), given by Günther and Yarrell, agrees very well with the above three specimens.

DESCRIPTION OF PLATE XIII.

[NOTE.—Reduced one-half from the author's original drawings.]

Salmo fario.

Fig. 1. Fac-simile head of female trout, taken in Lee Stream, Oct., 1877; weight, $4\frac{1}{2}$ lbs.

2. Fac-simile of dried head of female trout taken in Upper Taieri, Mar. 1878; weight 6 lbs. 6 ozs.

[NOTE.—The numbers represent the following bones: 1, pre-maxillary or inter-maxillary; 2, maxillary; 3, mandible; 4, operculum; 5, suboperculum; 6, interoperculum; 7, preoperculum.

Salmo trutta.

3. Fac-simile head of female, 7 lbs. weight, got in harbour, Nov. 6, 1877.

4. Do. do. dried specimen, 1 lb. weight, got in Otago Harbour, March, 1878.

5. Hand-sketch head of specimen, $1\frac{1}{4}$lbs. weight, in Otago Museum; caught at Otago Heads, April, 1874.

List of Young Trout distributed since 1869.

(From the Report of the Otago Acclimatization Society for the Years 1876 and 1877.)

Name of River.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Abbott's Creek	..	..	..	..	..	200	..	..	..
Ahuriri (Waitaki)	..	..	..	..	..	..	300	286	..
Ahuriri (Glenoamaru)	..	..	..	..	..	..	..	..	255
Akatore Creek	..	..	..	..	75	150	500	..	..
Awahokoma (Waitaki)	..	..	..	..	..	..	..	120	..
Awamoka	..	..	..	..	..	101	..	..	..
Back Creek (Clydevale) ..	..	..	..	..	..	..	..	700	..
Beaumont	..	..	..	..	..	..	100	..	..
Beck's Creek (Manuherikia) ..	..	..	..	..	75	..	..	..	..
Benger Burn	..	..	..	..	75	..	..	..	..
Black Burn	..	..	..	..	..	..	200	..	..
Boat-harbour Creek	80	..	..	..	50	..	500	..	520
Branch (Waipahi)	..	..	..	..	..	..	200	..	..
Boundary Creek (Waihola) ..	..	..	..	..	50	..	..	..	256
,, ,, (Kaitangata ..	..	..	..	..	..	..	54	..	..
,, ,, (Oamaru) ..	..	..	..	..	..	..	..	60	..
Bullock Creek (Wanaka) ..	..	..	..	..	..	..	..	50	..
Catlin's River	..	..	..	..	..	..	..	..	270
Clifton (Kaihiku)	..	..	..	..	50	..	..	..	..
Clutha (Albertown)	..	..	..	..	..	..	..	354	..
Clydevale Station Creek ..	..	..	..	..	..	..	..	210	..
Crookston Burn	..	..	..	..	..	50	..	..	..
Creek at Gore	..	..	..	..	..	..	..	51	..
Deep Stream	100	..	..	..	..	..	..	..	..
Eearnscleugh	..	..	..	..	..	..	..	800	*400
Fall's Creek (Kaitangata) ..	..	..	..	..	..	..	152	..	..
Fern Burn	..	Details have not been kept.	Details have not been kept.	No trout hatched this year.	..	..	..	51	..
Flagstaff Creek	..	..	..	..	..	60	100	..	..
Flag Swamp Creek	..	..	..	..	200	..	..	..	..
Flodden	..	..	..	..	40	..	..	..	..
Fraser's Creek	..	..	..	..	..	300	500	..	..
Fruid	..	..	..	..	..	225	80	..	..
Fulton's Creek (West Taieri) ..	76	..	..	..	..	..	..	..	..
Glenoamaru	..	..	..	..	..	..	500	140	..
Hakateramea	..	..	..	..	..	..	..	450	..
Halfway Creek (Rock and Pillar)	..	..	..	..	..	..	50	..	..
Hawea River	..	..	..	..	..	..	..	453	..
Hawke Bay	..	..	..	..	109	..	..	..	..
Hillend (F. S. Pillans)	..	..	..	..	..	..	300	..	..
Island Stream	48	..	..	..	..	..	..	..	..
Jack Hall's Creek (Wanaka) ..	..	..	..	..	..	..	..	105	..
Kakanui	53	..	..	..	..	..	..	..	..
Kaihiku	..	..	..	..	150	250	500	50	..
Kaikorai	..	..	..	..	..	200	100	..	..
Kaiwera	..	..	..	..	..	100	..	..	..
Kaitangata Creek	..	..	..	..	..	..	304	..	..
Kilmog Creek, or Waihemo ..	51	..	..	..	..	..	..	..	..
Kuriwao	..	..	..	..	..	204	620	..	100
Kurow	..	..	..	..	..	..	..	305	..
Lake Ohou	..	..	..	..	..	..	222	300	..
Lauder	..	..	..	..	605	..	..	..	..
Lees Canal	..	..	..	..	100	..	200	..	..
Lee Stream	98	..	..	..	..	..	..	..	..
Lindis River	..	..	..	..	..	..	..	..	†520
Linn Burn	..	..	..	..	..	..	30	..	..
Leithan	..	..	..	..	..	100	..	..	..
Carried forward	506	..	..	..	1,579	1,940	5,512	4,485	2,321

* All died on journey.

† All died on journey but 50.

List of Young Trout—*continued.*

Name of River.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Brought forward	506	..	..	..	1,579	1,940	5,512	4,485	2,321
Lovell's Creek	..	..	..	..	42	300	500	..	..
Luggat Burn	..	..	..	..	..	..	..	250	..
Manor Burn	..	..	..	..	..	..	150	..	..
Manuherikia (Upper)	..	..	..	..	242	..	..	..	..
Marshall's Creek (Clinton) ..	..	..	..	..	..	..	210	..	..
Matatapu	..	..	..	..	..	..	..	144	..
M'Pherson's Creek (Waipori Lake)	..	..	..	..	50	..	..	..	..
Matukituki	..	..	..	..	..	..	..	122	..
Mataura	..	..	..	..	..	..	50	..	..
Meggat Burn (Waihola) ..	..	..	..	..	..	..	..	..	390
Merton Creek	..	..	..	..	..	..	50	..	..
Mimihou	..	..	..	..	..	..	300	..	..
Oamaru Creek	..	..	..	..	..	..	75	..	..
Okapua (Mataura)	..	..	..	..	..	..	..	200	..
Oamarama (Waitaki)	..	..	..	..	..	..	200	200	..
Otakaike ,, ...	..	..	..	..	..	122	165	950	..
Otama (Mataura)	..	..	..	..	..	..	..	200	..
Otaria ,, ...	..	..	..	..	..	..	600	..	..
Otamaite ,, ...	..	..	..	..	..	..	..	536	..
Otematata (Waitaki)	..	..	..	..	..	..	..	320	..
Otepopo River	101	..	..	..	..	..	..	..	..
Owake (Upper)	..	..	..	..	..	..	..	290	800
,, (Lower)	..	..	..	..	..	..	..	600	..
Owiho (N. E. Valley)	..	..	..	..	50	..	100	..	..
Peat Bog Creek (Pomahaka) ..	..	..	..	..	..	50	..	..	..
Pleasant River	..	..	..	..	400	..	..	..	..
Pomahaka	..	..	..	..	125	200	1,720	1,250	2,000
Pomahi	..	..	..	..	..	100	..	..	..
Puerua	..	..	..	..	100	300	1,000	1,162	700
Pukerau	..	..	..	..	..	..	..	250	..
Quail Burn (Waitaki)	..	..	..	..	..	..	100	100	..
Quartz Creek (Wanaka) ..	..	..	..	..	..	..	..	252	..
Rankle Burn	..	..	..	..	..	..	500	..	..
Ronald's Creek (Pomahaka) ..	..	..	..	..	..	50	..	..	..
Rumbling Burn (Wanaka) ..	..	..	..	..	..	..	..	202	..
Sawyer's Bay Creek	..	..	..	..	..	100	..	..	..
Silver Stream	55	..	..	..	100	200	652	..	620
Sheepwash Creek	..	..	..	..	..	..	..	40	..
Shag Creek (Akatore)	..	..	..	..	..	100	..	..	..
Shag River	53	..	..	..	..	..	..	..	..
Young's Ponds	75	..	..	..	..	..	..	..	..
Station Creek (Benmore) ..	..	..	..	..	..	..	170	110	..
Stoney Creek	..	..	..	..	..	..	50	..	..
Swift Creek	..	..	..	..	..	50	..	..	..
Swinburn	..	..	..	..	250	..	..	..	..
St. Leonards	..	..	..	..	..	60	..	..	..
Taieri (Upper)	..	25	..	..	..	..	425	..	..
Talla	..	..	..	..	..	225	120	..	..
Tautuku (Upper)	..	..	..	..	..	..	..	..	220
Teviot	..	..	..	..	157	..	..	..	..
Tokomairiro	62	..	..	..	..	..	500	..	600
Trotter's Ck. & Hampden Str'ms.	..	..	..	..	1,000	..	..	..	..
Trumble's Creek	..	..	..	..	..	..	100	..	..
Tuapeka	..	..	..	..	..	..	400	..	..
Waikoikoi	..	..	..	..	..	150	..	..	..
Waikouaiti River	61	..	..	..	..	..	..	..	..
Carried forward	913	25	..	..	4,095	3,947	13,649	11,663	7,651

List of Young Trout—*continued.*

Name of River.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Brought forward	913	..	..	..	4,095	3,947	13,649	11,663	7,651
Waitapeka	..	Details have not been kept.	Details have not been kept.	No trout hatched this year.	..	100	..	..	..
Waihemo, or Kilmog	..				..	..	500	..	..
Wairuna	..				..	125	500	..	..
Waitahuna	..				..	..	500	..	800
Waireka	..				..	..	500	..	..
Waitati (Upper)	..				100	..	..	..	..
,, (Lower)	57				..	250	500	..	820
Water of Leith	75				..	450	..	..	650
Waterworks Reservoir ..	40				..	..	..	..	..
Waikaka	..				..	..	..	563	..
Waikouaiti	..				..	80	350	..	..
Waimea	..				..	..	..	300	..
Waipahi { Top waters	..				..	..	..	..	1,000
Waipahi { Trumble's	..				..	300	1,100	..	1,300
Waipahi { Lower	..				76	401	700	..	..
Waiwera	..				150	450	900	..	1,000
,, (top)	..	..	..	..	..	..	..	..	600
Wyndham	..	..	..	..	..	..	500	..	410
Washpool and other Creeks ..	..	..	..	..	70	..	..	..	..
Mr. Clark (Wairuna)	..	..	..	..	..	..	100	..	..
,, Larnach (Peninsula) ..	..	..	..	..	150	..	..	150	..
,, Reid (Elderslie)	..	..	..	..	200	..	..	1,000	..
,, Menlove (Windsor Park) ..	..	..	..	..	..	..	..	150	..
,, McGregor, C. E.	..	..	..	..	..	125	..	500	..
,, C. R. Howden	..	..	..	..	..	..	..	500	..
,, Wheatley (Kakanui) ..	..	..	..	..	..	..	..	800	..
Totals	1,085	1,000	2,000	..	4,841	6,228	19,799	15,626	14,231

List of Young Trout distributed from the Wallacetown Salmon Ponds, Southland by Mr. Howard.

Name of River.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Benmore Creek	..	..	..	310	..	..	..	..
Centre Creek	50	..	..	..	..	..	..	..
Clutha River	..	..	210	..	..	..	..	..
Eyre Creek	50	..	..	..	..	..	..	..
Makarewa (Upper)	350	..	..	..	..	..	..	..
,, (Lower)	..	82	..	220*a*	500	125	41*a*, 82^{b}	25*a*, 11*b*
Mataura (Upper)	..	..	..	160	..	..	..	..
Mimihou River	..	..	..	..	..	..	500	..
Morley Creek	..	..	..	..	500	800	..	..
Omut ,, ...	..	60	50	..	..	..	..	..
Orawia	..	..	..	..	500	..	..	..
Oreti River	..	..	..	..	450	1,000	1,500	75
Otamaite Creek	..	100	..	..	..	..	..	..
Otipiri (Upper Makarewa) ..	..	..	..	..	..	1,500	..	..
Puni Creek	..	..	100	..	..	..	..	..
Titiroa	..	..	..	..	..	..	250	..
Waiau River	47	..	..	..	500	..	..	..
Wakatipu Lake	100	..	..	..	..	..	..	..
Waikaka River	..	..	..	..	..	..	350	..
Waikivi ,, ...	117	..	100	..	..	..	..	..
Waihopai ,, ...	100	..	..	..	..	..	..	..
Waimatuku River	..	..	..	147	..	500	..	..
Winton Creek	..	..	..	205	..	..	..	..
Wyndham River	..	..	..	..	..	..	1,000	..

a, yearlings; *b*, old fish, some 10lbs. weight.

ART. XXV.—*On some new Fishes.* By F. E. CLARKE.

Plates XIV. and XV.

[*Read before the Westland Institute, 16th July*, 1878.]

Trypterigium dorsalis. Pl. XV.

B.6, D.4–19–12, P. 8 branched, 7 simple, V.2, A.25, C.13.

Head is to total length as 4 is to 19.

Total length, 5·1 inches; length of caudal fin, ·65 inch; length of head, 1·1 inch.

Length of 1st portion dorsal,	·6 inch	—extreme height,	3rd ray,	·35 inch
,, 2nd ,, ,,	1·9 ,,	,, ,,	12th ,,	·6 ,,
,, 3rd ,, ,,	·9 ,,	,, ,,	4th ,,	·63 ,,
,, anal ,, ,,	1·9 ,,	,, ,,	22nd ,,	·48 ,,
,, pectoral, 9th ray	1·15 ,,			
,, ventrals, 1st ray	·55 ,,			
Longest diameter orbit of eye	·3 ,,			
Shortest do.	·17 ,,			

Distance from commencement ventrals to do. anal, 1·2 in.

Termination of bases 3rd portion of dorsal and anal fins in same vertical, and 0·4 in. from commencement of caudal fin; commencement of 1st portion of dorsal fin slightly behind vertical from posterior margin of preoperculum, at terminal portion fin-membrane connected half-way up 1st ray of 2nd dorsal; fin-membrane at termination of second dorsal connected with 1st ray of 3rd dorsal; gill openings very large, branchiostegous rays very strong; rays of ventral exceedingly fleshy; lower simple rays of pectorals also strong and fleshy; body covered with small ctenoidal scales, arranged in well-marked transverse series; lateral line running low down on side with concavity towards dorsal aspect, *plainly marked from commencement to caudal fin.* Head, throat, base of pectorals, gill-covers, and cheeks scaleless. Summit of head dotted with numerous papillæ; portion of back, of a breadth of 0·1 in. on each side of and along base of dorsal fins, devoid of scales, division between scaled and scaleless portion being very harshly marked; eyes, oval medium, with strong supra-orbicular ridges; portion of forehead between eyes, narrow and grooved; profile almost vertical, cheeks wide and deep, and slightly flattened; body broad, rounded, thick, and fleshy, but elongate; mouth small, underhung, with fleshy lips, upper protruding beyond lower; nostrils single, very minute, close below eye, and with tubular orifice; no crests; tongue fleshy. Female fish, ova fully developed.

Ground colour of body, head and fins, brownish; and sides with yellowish tinge, mottled and spotted with darker, verging into banded appearance near tail; pupil of eye black, iris brown, with yellow ring round pupil.

Captured at mouth of Hokitika, 26th January, 1871, and presented by Mr. Moss Levy.

Trypterigium decemdigitatus. Pl. XV.

B.6, D.3–19–14, P.3–6–9, V.2, A.29, C.13.

Scales: lin. lat., 43; lin. trans. $\frac{4}{9}$.

Lateral line, convex, very prominent and plainly marked to near caudal (over 34 scales), when it ends abruptly, it follows general slope of dorsal aspect, high up on body; head is to total length as 1 is to 5; depth is to body and tail as 5 is to 27.

Teeth recurved, small, with row of larger (cardiform) outside on upper and lower jaws; teeth on vomer; tongue thin, sharp-pointed; caudal fin large, rounded; scales large, ctenoid, continuous to base of dorsal fins; none on head, cheeks, gill-covers, bases of pectorals or throat; eyes large and round; orbicular ridges hidden in substance; a supra-orbital fringed palmiform, tentacle—decemfid—on simple base stalk; trifid tentacle at nostril; upper jaw protrudes slightly beyond lower when mouth is closed—when open, lower jaw is longest; head small, profile sharp and sloping, top of head and snout very much rounded, muzzle pointed; commencement of first portion of dorsal fin in vertical with margin of pre-operculum and base of ventrals, terminating membrane of same joins with second portion at base of first ray; commencement of second portion in vertical with base of pectoral fins, terminating membrane of same joins first ray of third portion a little distance up ray; ventral fin rays slight but long; a strong papilla at anus; bases of rays of first portion of dorsal fin very close together, and far separate from the commencement of second portion of dorsal; termination of third portion of dorsal in vertical with termination of anal fin; head and gill-covers with numerous pores; nostrils double, one close to edge of orbit, the second lower and with tentacle; back and belly rounded, sides and tail flattened.

Total length, 3·2 inches; depth, ·42 inches; length of head, ·65 inches; diameter of eye, ·15 inches.

Length of 1st portion of dorsal	·35 inch	—extreme height of 3rd ray	.45 inch
" 2nd " "	1·1 "	" " 7th "	·35 "
" 3rd " "	·63 "	" " 4th "	·4 "
" anal	1·35 "	" " 24th "	·35 "
" caudal	·45	distance from snout to ventral fins	·5 "
" pectorals (12th ray)	·65	ditto from ventrals to anal	·7 "
" ventrals (2nd do.)	·5	ditto from end of anal and dorsal fins to the commencement of caudal	·2 "

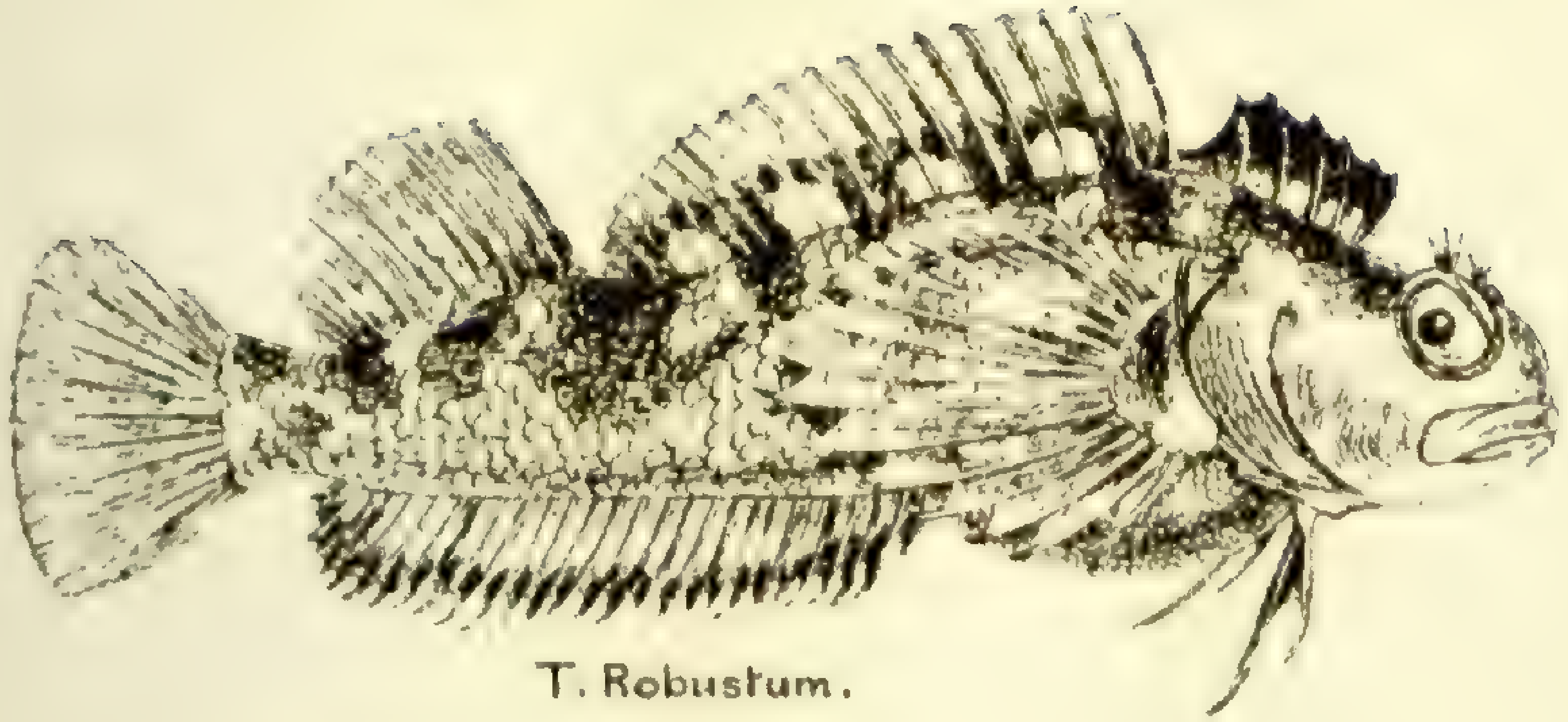
Colour (preserved in carbolic solution), sooty black; tips of anal fin rays and membranes between (central) caudal fin rays, almost immaculate.

Collected by Mr. Wm. Docherty, Dusky Sound, March 1877.

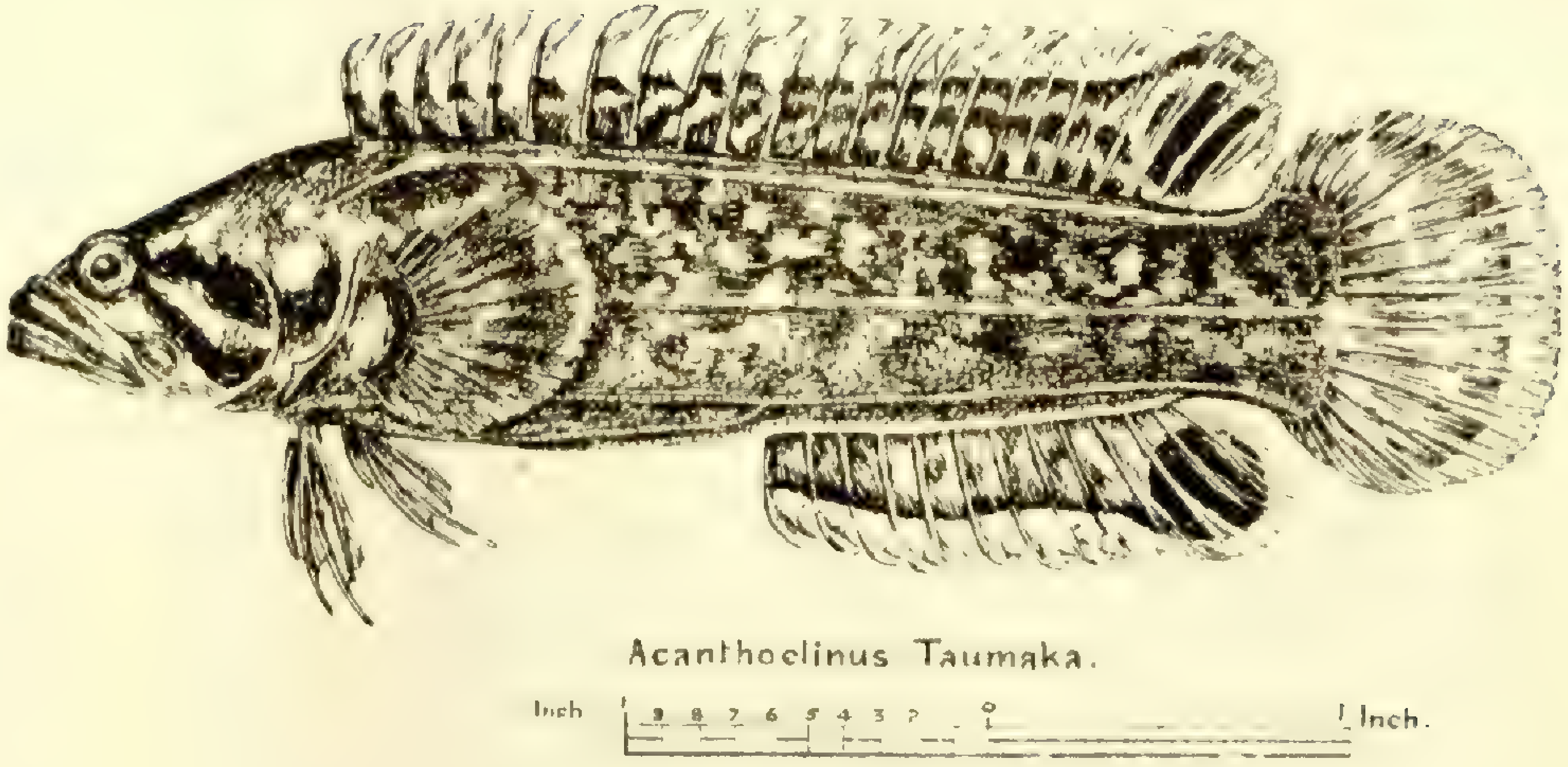
Trypterigium robustum. Pl. XV.

B.6, D.6–20–14, P.1–9–7, V.2, A. 28, C. 16.

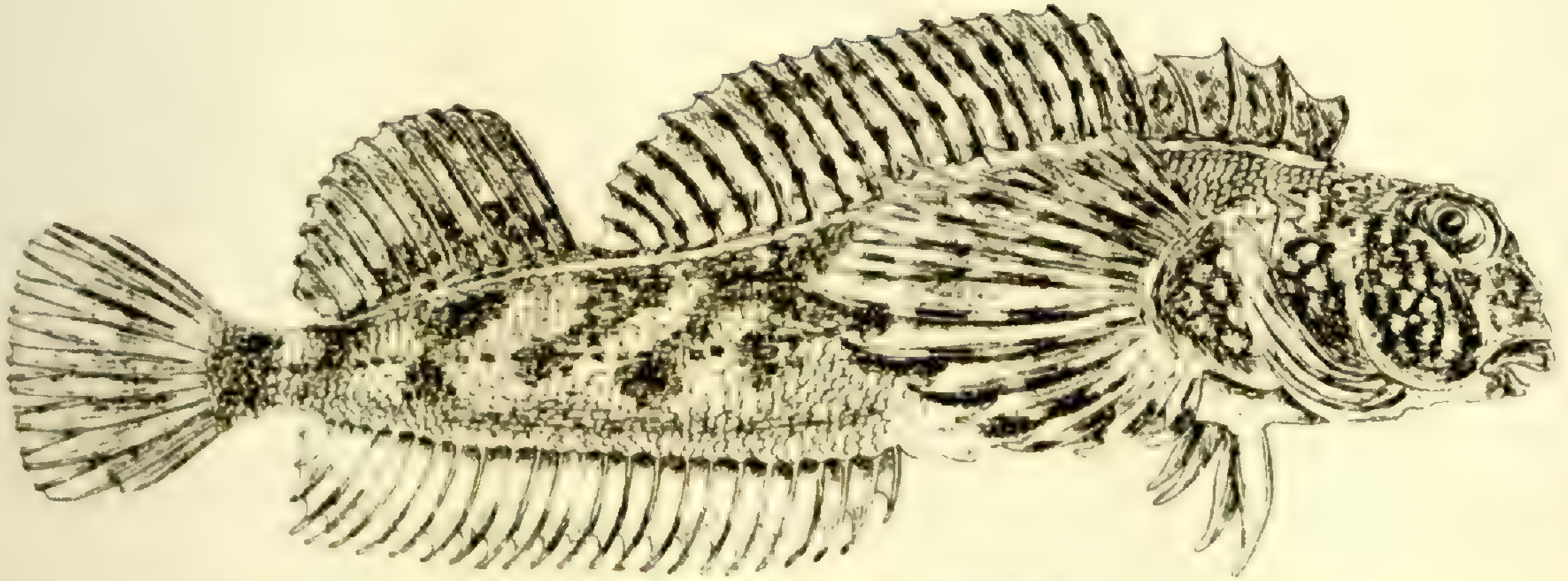
Head is to total length as 1 is to 4.



T. Robustum.



Acanthoclinus Taumaka.



Trypterigium Dorsalis.

T. Decemdigitatus.

F.E. Clarke, del.

Scales large, ctenoidal; head, cheeks, gill-covers, scaleless; eyes, large, oval; with trifid supra-orbital tentacle; nostrils double, one close in front of eye, simple, the other lower down, tubular; lips fleshy; profile of head high, but round; top of head round, nose round, blunt; supra-orbital ridges not very prominent, but fleshy; lateral line prominent, following dorsal profile, high up on sides, and terminating suddenly under last third of 2nd portion of dorsal; 1st portion of dorsal, very low; bases of 1st and 2nd rays close together, terminating portion of membrane joins 1st ray of 2nd portion of dorsal a little above base; 2nd portion of dorsal high anteriorly; membrane at termination does not reach to commencement of 3rd portion of dorsal; 3rd portion of dorsal high; belly tumid; body, thick fleshy, sharp on back, rounded below :—

Total length, 3·35 inches; length of head, ·8 inch.

Length,	1st part dorsal,	·45 inch	—extreme height,	4th ray,	·25 inch.
,,	2nd ,, ,,	1·25 ,,	,, ,,	2nd ,,	·38 ,,
,,	3rd ,, ,,	·55 ,,	,, ,,	3rd ,,	·4 ,,
,,	anal, ,,	1·27 ,,	,, ,,	17th ,,	·33 ,,
,,	caudal, ,,	·45 ,,	ext. ht. of pectoral,	11th ,,	·76 ,,

Longest diameter eye, ·2 ,,

Shortest ,, ,, 1·5 ,,

Distance from snout to ventral fin, ·55 inch

,, ,, ventral fin to anal fin, ·8 inch

,, ,, end of anal (in vertical with end of dorsal) to beginning of caudal fin, ·27 inch.

,, between 2nd and 3rd portion of dorsal fin, ·05 inch.

Ground colour (preserved in carbolic solution) brownish, with dark brown blotches on back, surrounding seven light patches or spots, four of which run up on to base of second portion of dorsal; upper part of first portion of dorsal very dark, anal fin greyish, with dark brown free margin; belly grey; pupil of eye black, iris brown.

Collected at Jackson's Bay, December, 1874, and presented by J. S. Browning, Esq.

Acanthoclinus taumaka. Pl. XV.

B.6, D.20–4, P.1–17, V. 1–2, A.9–4, C.19.

Head is to total length as 5 is to 21.

Total length, 4·3 inches; length of head, 1 inch; depth of body, ·8 inch

Length of dorsal,	2·3	inches—extreme height,	21st ray,	·55 inch
,, anal,	1·15	,, ,, ,,	11th ,,	·55 ,,
,, pectoral,	·5	,,		
,, ventral (2nd ray)	·65	,,		
,, caudal,	·6	,,		

Teeth on tongue, vomer, palatines upper and lower jaws.

Lateral lines as in generic distinctions. Head small and pointed, but with nose (in profile) slightly truncated, rounded above, flattish below;

sides very flat; tail compressed flat; caudal fin large, rounded; eyes round; lips very thick and fleshy; cheeks fleshy; head, cheeks, gill-covers and throat, scaleless; body, sides and belly covered with small, smooth, close-set scales; fins thick; terminating membranes of spinous rays of dorsal and anal fins slightly produced in fleshy appendages; pectorals small, round; no simple rays to pectorals; anal with one spine and *two rays only.*

Ground colour, brownish-grey, mottled with black; dorsal and anal fins with large black spot on rayed portion; base of spinous portion of dorsal with irregular blackish bands, and both dorsal and anal margined with black; summits of spinous appendages pink, with lower membrane immaculate; two black streaks on cheeks.

Collected and presented (with 5 of the same species) by Mr. J. N. Smyth, Jackson's Bay, December, 1874.

Lepidopus elongatus. Pl. XIV.

B.6, D.155, P.12, V. {minute rudimentary}, A.25, C.18.

Total length, 27·6 inches; greatest depth, ·7 inch; width (at vent), ·2 inch; vent, 9·6 inches from tip of snout; 6·5 inches from end of head; diameter of eye, ·5 inch.

Body scaleless, but covered with a delicate, deciduous, silvery pigment, adhering to fingers on handling; length of gape 1 in.; body long, narrow, and compressed; cheeks flat; dorsal fin long and low, extends from top of head above gill-opening to half an inch from base of caudal fin; extreme height, near termination, almost equals half the depth of body; pectoral fins with lower rays longest, length 1 in.; ventral fins, minute rudimentary, placed in vertical with posterior termination base of pectorals; length of anal 4·5 in., equals height of dorsal and terminates in vertical with end of same; caudal fin deeply forked; tail, before commencement of caudal, very slender and slightly carinated; nostrils situate ·2 in. in front of orbit, simple and single; gill-openings large; mouth large, gape extends to under nostril; teeth in single row (eight in number) on each intermaxillary bone (lancet-shaped and inclined slightly forwards), five long recurved fangs at extreme end of upper jaw, two on each side and one at symphysis; on lower jaws, single row of incurved lancet-shaped teeth (eleven in number on each side) with two small recurved fangs at end of jaw; no teeth on tongue palate or vomer; pharyngeal teeth very fine, brush-like; lower jaw (at symphysis) produced in a strong conical point, or quasi-barbel, ·5 in. in length; lateral line strongly but evenly marked—yellow.

Colour, a uniform bright metallic silver; fins, yellowish; caudal with pinkish hue.

Collected by self, Hokitika beach, 12th October, 1874, and the only perfect specimen of some eight or ten which have come under my observa-

tion. All were in the same proportion as the one above described, and varied but little in size; but were generally much mutilated by attrition on the sand and shingly beach.

ART. XXVI.—*On a new Fish found at Hokitika.* By F. E. CLARKE. Plate XIV.

[*Read before the Westland Institute, 8th January,* 1879.]

THE fish, hereafter described, and the occurrence of which on the West Coast of New Zealand I have the honour to bring under your notice this evening, is interesting on account of its being the first of its genus discovered in the seas of the southern hemisphere, or, in fact, in any other but European waters.

Hitherto they have been found off the coasts of Norway, Scotland and islands (very rarely), and the Mediterranean, in which sea a common variety occurs, which is notable as affording the silvery pigment formerly used in the manufacture of artificial pearls.

The first British specimen was noted by Yarrell in 1837, and was caught off Rothsay in the Isle of Bute, and British specimens have been but few in number since then. It is stated that all specimens obtained there, and off the coast of Norway, occur usually after severe and cold wintry weather, and this kind of weather ushered in the arrival of our species which was found washed on shore on the South Spit, Hokitika, 6th August, 1878, by W. Duncan, waterman, and was kindly brought under my notice by Capt. Turnbull, harbour master, under the impression that it was one of the young Californian salmon lately liberated in the river. It turned out to be one of the *Salmonidæ*, though not the one wished for.

As far as can be arrived at, by comparison with descriptions, etc., our specimen agrees very well, except some ill-defined peculiarities, with the Hebrides variety, and it would be of excessive interest to have more proof than mere imagination, that our antipodean species had gradually worked its way "sub mare" in those cold lower strata of water to our coasts.

The specimen has been forwarded as a "type" to the Colonial Museum, Wellington.

Argentina.

Scales rather large; cleft of mouth small; intermaxillaries and maxillaries very short, not extending to below the orbit; eye large; jaws without teeth, an arched series of minute teeth across the head of the vomer, and on the fore part of the palatines; tongue armed with a series of small curved teeth on each side (except in one species); dorsal fin short, in advance of the ventrals; caudal deeply forked.

Pseudo-branchiæ well-developed. Pyloric appendages in moderate numbers; ova small.

Marine fish which never enter fresh waters, and hitherto found only in some parts of European waters, *i.e.*, coasts of Norway, rarely coasts of Scotland and islands and the Mediterranean.

Argentina decagon, nov. sp.

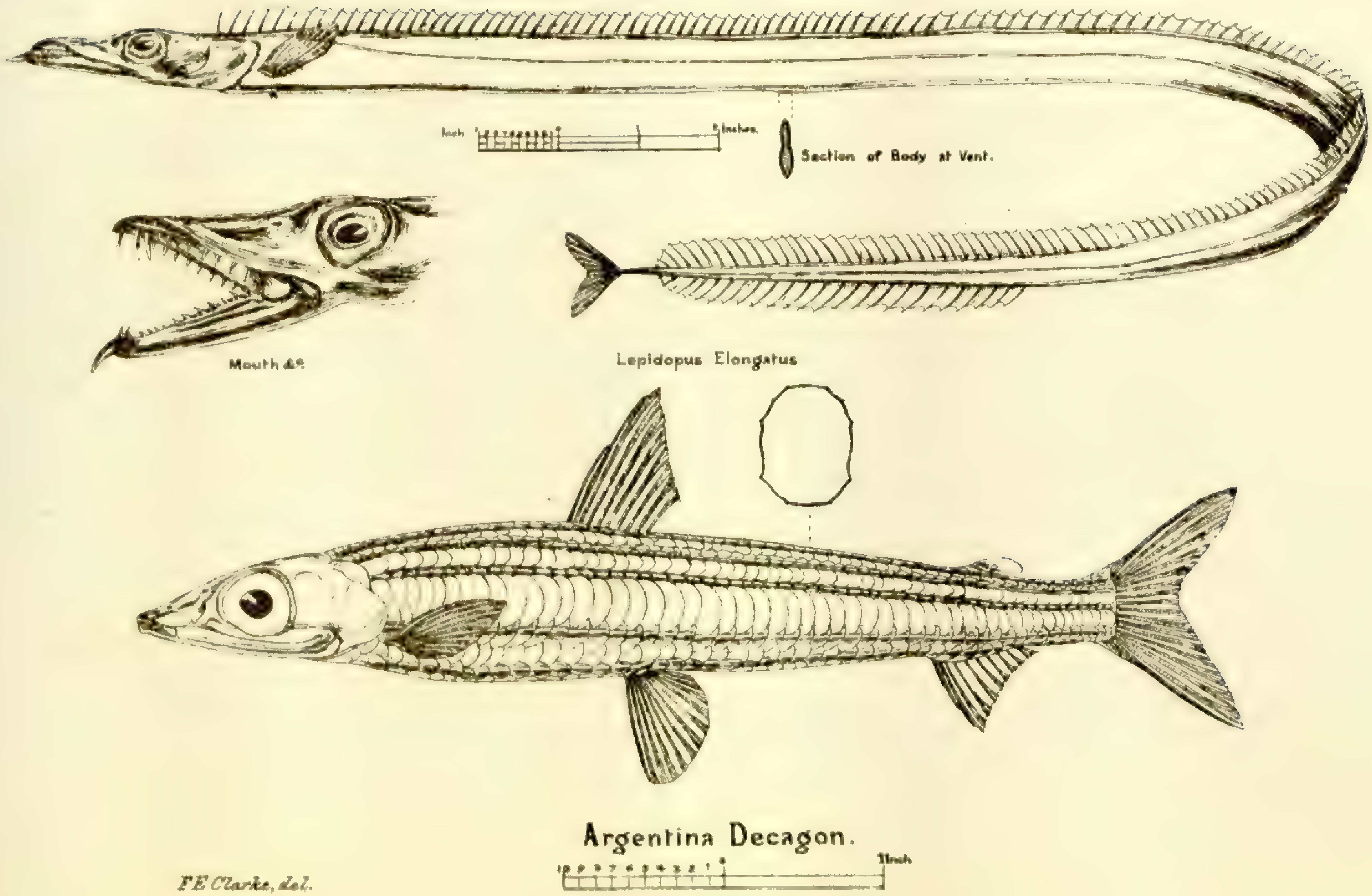
D.10, 2nd adipose; P.14; V.12; A.11; C.19; B.5; L. Trans. $\frac{4}{1}$; L. Lat. 51.

First dorsal situated in depression on back; adipose dorsal high; pectorals small, fragile; ventrals rather large, fragile, large axillary scale; caudal large, deeply forked; eye large, round; mouth very small, and protractile to some extent; anal fin very high anteriorly (this fin and adipose dorsal placed close to caudal; cheeks and head scaleless, top of head flat, head small, snout pointed; operculum, suboperculum and preoperculum covered with thick transparent (immaculate) glossy flesh (showing colouring pigment on bony plates in a very beautiful manner); lower angle of preoperculum and interoperculum free from fleshy substance; nostrils small, double, one placed before vertical of front of orbit, the other near tip of snout; back, belly and sides rather flattened, but body thick.

No teeth on superior or intermaxillaries or on inferior maxillaries, but the front edge of vomer is produced and bare and crenulated, forming dental apparatus; edges of palatines bared, forming cutting apparatus; tongue long, thin, narrow, and round, with four long recurved fangs at tip; gill-arches armed with long rakers; gills four and one pseudo-gill; upper jaw projects slightly over lower.

Head rounded under throat; eye large; gill-opening large, section through body shows same to be an irregular decagon in shape.

Scales (in beautifully arranged series) very large, thin, and covered with silvery pigment on lateral band, very bright, duller on series superior and inferior to same. Scales along lateral line high and narrow, with large core, the opening of which is directed towards head. At the angles of the irregular decagon the scales are large, squared in front, rounded at back, and bent in an angular form with an opening or slit extending some distance into scale. These scales overlap in the centres of the facets of the decagon, and over these, and extending nearly from angle to angle, are, on the dorsal, second, third lateral band and ventral facets superposed, large deep rounded scales filling up intervals between angles of decagon, and causing the ribbed appearance of body; the depression at lateral line is also caused by these large scales overlapping in unbroken marginal line, above and below same.



Argentina Decagon.

F E Clarke, del.

The substance of back and top of head, when first out of water, quite transparent; belly white; iris of eye silvery, pupil black, upper and lower sides silvery, but lateral band bright polished metallic silver.

Total length	6·9 inches.
Length of head	1·6 ,,
Length of head, body and tail (exclusive of caudal fin)	6·15 ,,
Distance from snout to commencement of dorsal	2·8 ,,
,, ,, ,, ,, ventrals	3·1 ,,
,, ,, ,, ,, anal	5·0 ,,
Width of eye, horizontal diameter, ·45 inch; vertical diameter, ·4 inch	
Greatest depth of body (under commencement 1st dorsal) ..	1·0 ,,
Length, base, 1st dorsal, ·5 inch; height, 1 inch	
,, ventrals, ·75 ,,	
,, pectorals, ·75 ,,	
,, base of anal, ·55 ,, height, ·55 inch	
Distance between commencement 1st dorsal and adipose ..	2·55 ,,
,, ,, ,, ventrals and anal	1·9 ,,
,, ,, adipose dorsal and commencement caudal ..	·9
,, ,, commencement anal and commencement caudal	1·18

Short diameter of eye (vertical), ¼ length of head
Length of head is to body and tail as 16 is to 61
,, ,, is to total length as 16 is to 69
Greatest depth of body is to total length as 10 is to 69
,, ,, ,, is to total length of head, body, and tail, as 10 is to 61
Distance from snout to commencement ventrals, 3·1 inches
,, ,, commencement anal to end of tail, 3·1 inches.

ART. XXVII.—*On a new Fish.* By W. D. CAMPBELL, C.E., F.G.S.

[*Read before the Westland Institute, 8th January,* 1879.]

THE following description is of a new genus of fish, four specimens of which were obtained by myself on the 18th of May last, on the Hokitika beach. It has very marked peculiarities. The single dorsal, and the stout spinous rays in both it and the anal, connected by a perforated membrane, presents entirely distinct characters from any previously described genus. The most nearly allied appears to be the genus *Brama.* There is a possibility that the specimens obtained are young, but the characteristic points described below appear uniformly in them all.

Fam. SCOMBRIDÆ.

Group 5. *Coryphænina.*

Genus nov. *Discus.*

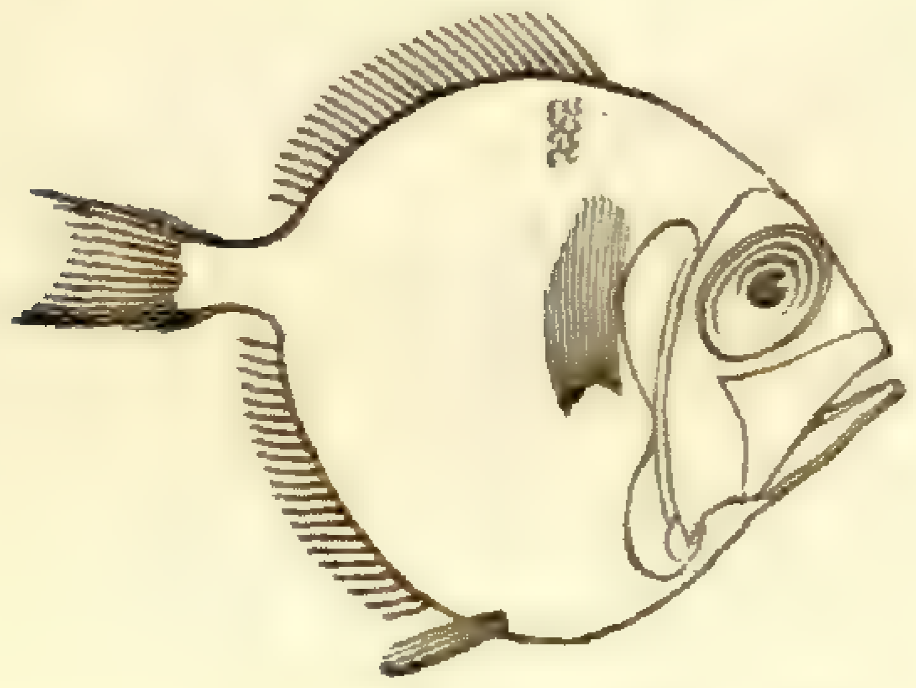
Body compressed and elevated; general form circular-pointed at snout and tail. Head and lower portion of body scaleless, minute scales on

upper portion of body and tail; cleft of mouth very oblique. A single dorsal, which, like the anal, is composed of stout spinous rays connected at their mid-length by a membrane having a breadth of one-third of their length, leaving apertures between the base of the rays. Caudal forked, ventrals slender; a single series of minute teeth in the jaws, finely pectinate; branchiostegals four; air-bladder large.

Discus aureus, sp. nov.

B.4, D.26, A.21, V.7, C.3/16/3, P.17.

The greatest height of body is two-thirds of length, and is vertical to the origin of the dorsal and ventrals; head equal to half height; snout equal to half, and interorbital space equal to one quarter greatest diameter of orbit, which is equal to half length of head; a depression extends down the snout; greatest thickness of body above the pectorals, and equal to greatest diameter of orbit; the upper maxillary extends to the vertical, below the centre of the eye; colour silvery, with minute bronze spots, with a dorsal margin of a similar colour, extending from behind the orbit, where the depth equals half orbit, to the caudal; pectorals yellowish brown, others dirty white.



Total length, 2¾in.

Four specimens cast up on Hokitika beach.

Art. XXVIII.—*Notes on the Genus* Callorhynchus, *with a Description of an undescribed New Zealand Species.* By W. Colenso, F.L.S.

Plate XVII.

[*Read before the Hawke Bay Philosophical Institute, 12th August,* 1878.]

In a "Catalogue of the Fishes of New Zealand with Diagnoses of the Species," compiled by Captain Hutton and printed for the Colonial Museum in 1872, only one species of the genus *Callorhynchus* is mentioned as belonging to our seas—*C. antarcticus;* but, as I take it, there are several other species, two of which I have seen, viz., *C. australis*, Hobson, and an undescribed one, which I believe to be a *species nova (C. dasycaudatus*, mihi), of which I shall give a fair diagnostic and specific outline in this paper.

It was in December, 1844, that I first saw this fish. I was leaving Poverty Bay in a brig, bound for this place, when, on passing the heads, we saw some Maori canoes fishing, one of which paddled alongside and sold us some of their fish they had just taken; among them was one that I had

never seen before; I knew it was of the genus *Callorhynchus*, and, as I thought, distinct from *C. antarcticus* (the only species of that genus then known to me), so I took a sketch drawing of it, with notes of its dimensions, etc., which I now give.

Callorhynchus dasycaudatus, mihi.

Total length, 3ft. 3in.; girth, (belly) 1ft. 5in.; length of pectoral fin, 9in.; first dorsal fin, 5in.; of attached bony ray, 7in.; length of tail, from angle in upper surface, 12in.; length from snout to anterior base of first dorsal fin., 9½in.; the bony ray in front of the first dorsal fin is partly separated from that fin, it is a little curved, and barbed slightly on the posterior edge; the extremity of the tail is free and feathered, which being such a great peculiarity and so very characteristic of this species, has given rise to its pecific name. Whole fish silvery white, but highly iridescent; the fins of dark grey colour. It had no teeth, only palatal bones; a crayfish was found in its maw.

In its produced whip-like tail and barbed dorsal spine this species approaches more nearly to its northern congener, *Chimæra arctica*, Linn., formerly the type of the genus, before that *Callorhynchus* was separated from it by Cuvier.

Captain Hutton, in the work above cited (p. 74), gives as a character of this *genus*, "extremity of the tail distinctly turned upwards:" I scarcely understand this; such is certainly *not* the case in the one species mentioned by him as belonging to these seas, *C. antarcticus;* neither does any such character belong to *C. australis*,—another of our species, which I have also seen. Both of those species also differ widely from *C. dasycaudatus*, in the very large size of their pectorals, which overlap the base of their ventrals. Drawings of the tails of those two species I also give in the subjoined plate.

I also note that Dr. Richardson, in a paper on some new Tasmanian fishes, read before the Zoological Society in 1839, has another new species, *C. tasmanius*, which may also be found here in our seas; I have, however, never seen it. It differs from those two species last mentioned in the size of its pectorals; in which respect it approaches to *C. dasycaudatus*. Dr. Richardson gives the following characters to distinguish it from *C. antarcticus* (probably at that time *C. australis* was unknown to him)—"*pinnis pectoralibus ad ventrales haud attingentibus*; *pinnâ dorsi secundâ pone ventrales incipienti, ante lobum anteriorem inferiorem pinnæ caudæ desinenti*." And then he adds: "This species agrees with the *Callorhynchus smythi* of Benne, figured in Beechy's Zoological Appendix, in the distance between the pectorals and ventrals, but is so unlike that figure in other respects that it is impossible to assign it to that species." Of this last mentioned species (*C. smythi*), I know no more than what I have here quoted; should it be found in our seas, then, we may probably count on having five species of this genus.

Dr. Hobson, of Tasmania, has given an admirable description of *C. australis*, which he dissected and described in 1840 (Tasmanian Journal of Natural Science, Vol. I.) This species is near to *C. antarcticus* in the size of its pectorals, etc., but widely different in the shape of its tail. Its length is said to be 2 feet 6 inches. His whole paper is replete with valuable and interesting information relative to the viscera, and other organs and parts of this peculiar fish. One short sentence only can I quote:—"The inferior extremity is especially interesting from its quadruped-like form; here is, in reality, the pelvis of the fish." I quote this the more willingly in hopes that some of our young anatomists (to whom that circumstance quoted may be unknown), may also be led to dissect and describe other species of this curious genus; seeing, too, that they are not uncommon here on our shores during the summer.

DESCRIPTION OF PLATE XVII.

1. Callorhynchus dasycaudatus, *Col.*
2. Callorhynchus antarcticus, *Cuv.* (tail only).
3. Callorhynchus australis, *Hobson* (tail only).

(N.B.—The figures are drawn to one scale).

Art. XXIX.—*Notes on the Metamorphosis of one of our largest Moths—* Dasypodia selenophora. By W. Colenso.

[*Read before the Hawke Bay Philosophical Institute, 10th June,* 1878.]

On the 21st January, 1878, my attention was called to an unusually large caterpillar, apparently asleep on the trunk of an Acacia tree (silver wattle). At first sight, it seemed so much like the bark of the tree in hue, that it was not readily distinguished from it. The larva was stretched out to its full length, nearly 3″ 6‴; it was elongate, and of the ordinary form, pretty evenly cylindrical throughout, though thickest in the middle and tapering towards its head and tail, and skin smooth. In colour, it was peculiarly mottled or finely speckled (irrorated) with very minute points of black, red (carmine), and ash colours—the latter predominating—which, combined, and at a little distance gave it the colour of the reddish-grey bark of the tree above-mentioned. It had two minute bright red (carmine) spots close together on its back, near the tail, and when in motion two large triangular dark splashes were displayed on its back; the colour of the belly of the larva was pale (dull white), with several round olive spots in pairs, corresponding to its belly feet. Its head was small, of a pale Indian-yellow colour; its hind feet were large, and it had also two broad anal feet,

CALLORHYNCHUS DASYCAUDATUS, sp. n.

W. Colenso, del.

On being touched, it coiled itself up very rapidly and closely. This it did many times, so that it was difficult to get to see its under parts. It did not seem inclined to crawl, and was very quiet. I put it under a large bell-glass, and tried it with various leaves, but it would not eat anything; so I left it, thinking it would shortly undergo its transformation.

The tree on which I found it was a large old one, and it was on its main stem about 4 feet from the ground; how it came there was a mystery, for there were no shrubs nor plants nor even grass near,—it being the very middle of our dry season (which this year was extreme), and while the upper overhanging branches of the tree were several feet above my head.

All that day and part of the next it remained very quiet, still keeping stretched out to its full length, but not moving; it ate nothing, though on the 22nd it discharged several large pellets (fæces), of an obtuse cylindrical shape.

I kept watching it daily, and on the 25th January I found it had spun a small white web (cocoon) with which it had managed to bring together and curl down around it the edges of a large leaf of the common red geranium, fastening also the leaf pretty closely to the sheet of paper below, so that I could not get a single glimpse of the larva, although I tried many ways; but as the weather was so hot and dry, and the leaf quickly withering, I soon left off making any further attempts to observe it, fearing I might injure the larva.

Several weeks passed and no sign of its change appeared; and I was almost getting tired of making so many diurnal visits, when, on the morning of the 21st of March, I found it had emerged a perfect insect, a large moth of wondrous beauty! I do not think that it had left its pupa-case during the night, as there was but a very small amount of its long downy covering about the glass; for had it done so, being a nocturnal creature and of a large size, it would surely have knocked itself about a good deal in its vain attempts to get out.

I may truly say that I gazed on it with pleasure and astonishment; for though I had pretty largely known our New Zealand *Lepidoptera* (having collected many hundreds of species some 25–40 years ago)* I had never before seen one like this. It differs too, very considerably from our British species, although I thought I had formerly seen something not altogether unlike it in books. There, however, it was, a handsome large black moth, forming almost an equilateral triangle of 1″·6‴ as it remained at rest. I

* I may here mention that the moth described in Dr. Dieffenbach's work on New Zealand, Vol. II., p. 284, (*Hepialus*) was also raised by me from larvæ which I had fed on *kumara* leaves, much to the annoyance of the Maoris in those times, who made a great fuss and objection to my so doing. (*See note at end.*)

knew that it belonged to the *Noctuina* group, but that was all. So I sent an outline of its appearance to Mr. Fereday, the celebrated entomologist residing at Christchurch, enquiring if there were any such specimens in the Museum there, or if he knew of such a moth. From Mr. Fereday I received a very kind and full reply, that, while there were no specimens of this moth in the Canterbury Museum, he had one (a female) in his own possession, which had been taken some years ago at Nelson; and that, though rare, the perfect insect had been described, and was the *Dasypodia selenophora* of Guenee.*

And now for a brief description of the perfect insect.

Its size across, with wings extended, is 3″ 3‴; length of body, 1″ 3‴; the body thick, with 7 segments, but tapering downwards rapidly from its second segment almost to a point at the tail (not unlike, in this respect, those well-known British species of the *Sphingidæ* family, *Smerinthus tiliæ*, and *Chærocampa porcellus)*, and densely covered with very long down. Antennæ, nearly 1″ long, slender and evenly attenuated, but not smooth, being apparently very finely and regularly ringed and serrulated; legs, large and stout.

Its colour, on the other side, when living, was a sooty black; but after death it changed to a dark umber colour, with dark zig-zag and other markings on its wings (somewhat resembling those on the wings of the Emperor Moth, *Saturnia pavonia-minor)*, and with a peculiar large and lustrous ocellated spot on each fore wing near the costa—in a line with the anal angle; all the wings are ciliated, bearing minute whitish dots at the extremities of the nerves or rays just within the margin. Its colour on the under side was ochrous or fulvous; the legs, amber-coloured below the knee, but its thighs were ochrous, and thickly covered with excessively long and waving down; its horns also were ochrous coloured but darker at their bases.

While living, it was a truly superb, rich, velvety-looking creature; presenting, too, when at rest, such a regular and graceful equi-triangular outline. The eyes on its wings had (if I may so express myself) a living look, much as the irises of the eyes of men and animals are sometimes drawn when represented under bright light. Those spots, or eyes, were all alike, black, but the two circular rims round each, and the lunate or triangular iris-pupil-like part within were shining lustrous and waxy, or as if strongly gummed. What with its fine moony eyes on its wings, and its long wavy down on its thighs, it well deserved its expressive name, both generic and specific. I could not help thanking its describer, for it is not often that we find so fit and distinguishing a name given in these modern

* In *Spéciès Général des Lépidoptères Nocturnes.*

times, either to an animal or to a plant. Much, however, of its surpassing beauty quickly faded after death, which I attributed to the fumes of the sulphur I had used in killing it, not having any chloroform at hand, and leaving home on that very day by train to visit the country schools.

The *pupa*-case (after the moth had emerged) is nearly cylindrical, very obtuse at the head, and tapering regularly downwards from end of folded wings at 4th segment, and pointed conical at the tail; length, 1″ 3‴, and diameter in thickest part 6‴; suspended slightly by tail; well-marked in front with folds of wings and antennæ, eyes and head of *imago*, and very strongly with 7-ringed segments, each having two long spiracle marks, one on each side. Colour dark red (garnet), with a blueish or violet bloom (dust), but smooth and shining on its prominent parts.

Cocoon very small, white and coarse, almost woolly; just sufficient to hold the edges of the leaf down to paper, where, however, it was strongly fastened; fæcal pellets emitted after enclosure.

The *imago* had made its exit by a small round hole at the top of pupa-case, back of the head, the case having also slightly given way down the costal marking of the wings on each side.

Note.—Dr. Dieffenbach saw the moth I had raised from the larvæ referred to (in the note, p 301), at my house in the Bay of Islands, where he was a frequent visitor during his stay there in the summer of 1840–1841; and from me the doctor obtained not a few specimens and much information (like many other visitors of that early period), which, however, he never acknowledged.

As it may be of some little interest I will just quote what I then wrote about that *larva* and *imago*, in a letter to Sir W. Hooker, dated "July, 1841," and published by him in the London Journal of Botany (1842), vol. I., pp. 304, 305.

"In a phial you will find specimens of what I believe to be the true *larvæ* of *Sphæria robertsii*.* These larvæ are abundant in their season on the foliage of *Batatas edulis* (?) †, the *kumara* of the New Zealanders; to the great distress of the natives, who cultivate this root as a main article of their food, and whose occupation, at such times, is to collect and destroy them, which they do in great numbers. They vary a little in colour, as may be observed in the specimens sent. The New Zealanders call them *Hotete* and *Anuhe* (the same names which they apply to the *Sphæria robertsii* itself), and always speak of them as identical with that *Fungus*. The common belief is, that both (those living on the *kumara* and those which bear the *Fungi*) alike descend from the clouds! this opinion doubtless arising from their sudden appearance and countless numbers.

* *Cordiceps robertsii.*—Hand-Book, Fl. N.Z.

† *Ipomæa chrysorhiza.*—Hand-Book, Fl. N.Z.

"A moth from the larvæ also accompanies the above, for I have fully satisfied myself of their identity. In 1836 I kept the larvæ under glasses, and fed them with the leaves of *kumara* (much to the annoyance of the natives), until the perfect insect was produced. There cannot reasonably exist a doubt that this insect deposits or drops some of her eggs on the branches of the raataa (*Metrosideros robusta*, A.C.), beneath which tree alone the *Sphæria robertsii* has hitherto been found, when they (the larvæ) fall to the earth beneath, die, and the *Sphæria* is produced.

"I think I can offer a fact for consideration relative to their being only (or chiefly) found beneath *Metrosideros robusta*. One fine evening last summer, when enjoying, as usual, a promenade in my garden, just as the sun had set, I was admiring the splendour of some plants of *Mirabilis*, which had just unfolded their scarlet petals. Suddenly several of these moths made their appearance, darting about the plants in every direction, pursuing one another, and eagerly striving to obtain the honey which lay at the bottom of the perianths of the *Mirabilis*. From this plant they flew upwards to the flowers of a stately *Agave* (*A. americana*), where, being joined by other moths, their congeners, their numbers soon increased; and thus they continued to enjoy themselves every evening during the whole season. The inference I deduce is this, that the *M. robusta*, blooming at this season, having scarlet flowers which abound in honey, becomes the centre of attraction of these insects—increased, too, by its densely crowded *coma* of inflorescence, more particularly so from the blossoms being always at the extremity of its branches; by which, and by their colour, this tree may at once be distinguished from the other denizens of the forest, even at a great distance.

"The larva whereon the *Sphæria* is found, when first taken out of the earth, is white internally, and appears solid and succulent. A finely-cut slice, when held against the light, presents a beautiful appearance."

I may further add that, 25–30 years back, I had a honeysuckle (*Lonicera periclymenum*) trained round the doorway of a house in my garden. This plant flowered abundantly in the summer, and it was interesting and curious of an evening to sit on the step (as I have often done) and watch those large moths (*Hepialus*); they would visit the plant in great numbers, and unrolling their long probosces, probe the flowers to get at the honey, passing quickly from flower to flower, and continually coiling and uncoiling their long trunks with great rapidity; they never lighted on the plant, and all the time kept up a tolerably loud humming noise from the quick and incessant vibrations of their wings, which, indeed, drew the attention of the cats, who often, in consequence, captured them.

ART. XXX.—*Further Notes on* Danais berenice, *in a letter from* MR. F. W. C. STURM to the Honorary Secretary, Hawke Bay Philosophical Institute.

[*Read before the Hawke Bay Philosophical Institute, 9th September*, 1878.]

"Hawke Bay Nurseries, 17th February, 1878.

"DEAR SIR,—In regard to the butterfly, *Danais berenice*, or a closely-allied species (as per your paper on the same),* the first time I saw it was at the Reinga, up the Wairoa River, in Hawke Bay, in December, 1840, or January, 1841. In 1848, I captured a number at the Waiau, a tributary to that river, the Wairoa; I cannot recollect how many, but it must have been eight or nine at least, as I sent some small collections of insects to several of my friends and correspondents in Europe, and all, or nearly so, had one or two of the *Danais* included. Again, in 1861, I captured three on the Rangitikei River (near to the Messrs. Birch's sheep-run), one of which I have still in my collection, although in a very imperfect state. About twelve years ago Mr. Brathwaite captured one in his garden at Napier; this he sent to England, and it came into the hands of the Rev. H. Clarke, who mentioned it to me in a letter, as we corresponded. Four years back I saw three or four in my garden here, and two years ago there were a great number in my gardens, always keeping about the Lombardy poplars and *Houheria populnea*. Mr. Duff, of Kereru, also informed me that he had captured one pretty high up on the east side of the Ruahine range, about ten years ago. I certainly believe the butterfly to be indigenous and not introduced; and my observations of it fully coincide with yours, that while, in certain years, it is plentiful, in other years it is not to be seen.—I am, dear sir, yours, etc., F. W. STURM."

ART. XXXI.—*Notes on some New Zealand* Echinodermata, *with Descriptions of new Species*. By Prof. F. W. HUTTON.

[*Read before the Otago Institute, 8th October*, 1878.]

Amphiura parva, sp. nov.

Small, disc pentagonal, covered with rather large imbricating scales, and a pair of large, nearly semi-circular, radial shields at each corner. Rays two or three times as long as the disc, tapering; upper plates broader than long with the outer edge convex; under plates laterally constricted, with a blunt tooth on each latero-anterior margin, and with the outer edge slightly emarginate. A single broad tentacle scale. Side plates with a row of three or four nearly equal spines, which are almost as long as the breadth

* Trans. N. Z. Inst., Vol. X., p. 276.

of the ray. Mouth shields triangular. The whole animal is of a pale brown colour. The distance between the tips of the rays is about three quarters of an inch.

Dunedin Harbour.

Asteracanthion graniferus, Lam.

A specimen of what I take to be this species is in the Otago Museum. It was found in Dunedin Harbour.

Asterias rupicola, Verrill, Bull. U.S. Nat. Museum, No. 3, 1876, p. 71.

A specimen of this species, found near Dunedin, has been presented to the Museum by Mr. A. Montgomery.

Echinaster fallax, Mull. and Troch. = *Othilia luzonica*, Gray.

The *Henricia occulata* of my Catalogue of the Echinodermata of New Zealand (1872) is the same as this species.

Echinaster (?) sp.

Rays seven; five and a half times as long as the diameter of the disc. A specimen 18in. in diameter from Waikouaiti, presented by Mr. Orbell. I cannot identify it.

Chætaster maculatus, Gray (*Nepanthia*).

I have placed with great doubt under this species a starfish that I have received from Wellington.

Pentagonaster dilatatus, Perrier, Arch. Zool. Exper. 1876, v., p. 33.

Asterina novæ-zealandiæ, Perrier, l.c., p. 228.

I have not seen any description of either this species or the last.

Asterina regularis, Verrill.

I have a variety of this species, from Dunedin, with six rays, which can hardly be distinguished from *A. australis*.

Goniocidaris canaliculata, A. Ag.

During a late visit to Sydney I was able to examine specimens of both *G. tubaria* and *G. geranioides*, and found that our species differed from both. It is, however, I think, identical with *G. canaliculata*; but the ocular pores are at the external angle of the plates, and Mr. Agassiz does not mention the trumpet-shaped secondaries surrounding the abactinial system. It has ten primary tubercles in a row.

Note.—Since reading this paper, I have seen the figure of *Goniocidaris canaliculata* in Sir Wyville Thomson's "Atlantic," and find that it is not our species. Our species may be called *Goniocidaris umbraculum*.

Salmacis globator.

Specimens sent to the Otago Museum, by Mr. C. Traill, from Stewart Island, appear to belong to this species. But there are eight or nine tubercles on a plate of the interambulacral system at the ambitus. The

test is white with pink tubercles; the integument a pale brownish yellow. The spines on the upper portion are reddish purple with white tips; on the lower portion they are white, getting yellow towards the base.

Diameter 2 inches. Height 1·4 inches.

Echinocardium australe.

A specimen of this species, presented to the Museum by G. Joachim, Esq., from Northport, Chalky Inlet, measures 2½ inches in length.

Molpadia coriacea, Hutton.

This is evidently not a true *Molpadia.* It is probably a *Caudina* or an *Echinosama*, but as the type is in the Wellington Museum, I cannot re-examine it.

Cucumaria thomsoni, sp. nov.

Body fusiform, scarcely subpentagonal. Skin rough, wrinkled. Ambulacra with the tubercles densely crowded in about 5 or 6 rows. No feet on the interambulacral areas. Tentacles—?

Rich brown, the white tips to the feet giving the ambulacral areas a spotted appearance. Length, 1¾ inches.

Stewart Island. Presented to the Museum by G. M. Thomson, Esq., after whom I name it. A single specimen in spirit.

Echinocucumis alba, Hutton.

The receipt of another specimen of the *Chirodota (?) alba* of my catalogue has enabled me to dissect it, and I find that it has five well-marked ambulacra, and should be placed in the genus *Echinocucumis*.

Labidodesmus turbinatus, sp. nov.

Body rounded, suddenly contracted posteriorly into a short-pointed tail, and anteriorly into a rather long cylindrical neck; skin smooth, slightly transversely wrinkled; the two dorsal ambulacra, with two rows each of rather distant feet; the three ventral ambulacra either like the dorsal or with more crowded feet in several rows. Tentacles—. Body white, covered with a brown epidermis, which easily peals off, except round the ambulacral feet. Length, 2½ or 3 inches.

Stewart Island. Presented to the Museum by G. M. Thomson, Esq. Two specimens in spirits.

PENTADACTYLA, gen. nov.

Feet evenly spread over the greater part of the body. Tentacles five, pedunculated, frondose; dental apparatus very large.

Pentadactyla longidentis, Hutton.

In the Catalogue of the Echinodermata of New Zealand (1872), p. 16, I described a Holothurian under the name of *Thyone longidentis*. It is, how-

ever, evident that it is not a *Thyone*, but belongs to the family *Aspidochirotæ*, and must form the type of a new genus, distinguished by having only five tentacles and scattered foot-papillæ. I therefore propose the name *Pentadactyla* for it.

Holothuria mollis, Hutton.

This species in many respects approaches *Stichopus*. I have had no specimens for dissection, and cannot therefore say whether the reproductive organs are in one or two bunches. A knowledge of this will settle to which genus it should be referred.

Holothuria robsoni, sp. nov.

Elongated, rather slender. Skin, smooth. Feet, scattered sporadically over the ventral surface, apparently none on the back. Pentacles, 20. Anus, round. Back, pale purplish brown; ventral surface, dirty white, with scattered brown spots. Length, 4½ inches.

Cape Campbell. Presented to the Museum by Mr. C. H. Robson, to whom I have much pleasure in dedicating it.

Art. XXXII.—*The Sea Anemones of New Zealand.* By Prof. Hutton.

[*Read before the Otago Institute, 11th June, 1877.*]

I should not have chosen such a pretentious title for this paper, but that I wished to include in it descriptions of the three New Zealand sea anemones that have not been found near Dunedin. The sea anemones are animals that can only be described from living specimens; they must be collected, brought home alive, and placed in water before their structure and colour can be seen, and when they are dead there is no known means of preserving them so as to be of any use. To enable observers, therefore, in any part of the colony away from libraries, to describe these animals, I have included in this paper not only descriptions of all the New Zealand species not described in our Transactions, but also an analysis of all the known genera.

Zoantharia-Malacodermata.

Analysis of the Families.

Base adherent at pleasure.

Tentacles all compound ... ... *Thalassianthidæ.*

Tentacles both compound and simple ... ... *Phyllactidæ.*

Tentacles all simple

Column pierced with loopholes ... ... *Sagartiadæ.*
Column imperforate.
Column smooth
Margin simple ... ... *Antheadæ.*
Margin beaded ... ... *Actiniadæ.*
Column warted ... ... *Bunodidæ.*
Base non-adherent.
Lower extremity rounded, simple ... ... *Ilyanthidæ.*
Lower extremity enclosing an air-chamber ... *Minyadidæ.*

THALASSIANTHIDÆ.

Analysis of the genera (after Milne-Edwards).

The tentacles of one kind only.
The trunk ramified.
The branches long and four-fingered ... ... *Thalassianthus.*
The branches inflated and with scattered papillæ *Actinodendron.*
The trunk simple.
The trunk with scattered branched filaments *Actinaria.*
The trunk with groups of rounded papillæ ... *Phymanthus.*
The tentacles of two kinds.
The internal with globular papillæ, the external laciniated ... ... *Sarcophianthus.*
The internal laciniated, the external granulated ... *Heterodactyla.*

PHYLLACTIDÆ.

Analysis of the genera (after Milne-Edwards).

Compound tentacles on the margin of the disc.
Column smooth ... ... *Phyllactis.*
Column warty ... ... *Oulactis.*
Compound tentacles on the disc, between two circles of simple tentacles ... ... *Rhodactis.*

SAGARTIADÆ.*

Analysis of the genera (after Gosse).

Tentacles moderately long, slender.
Disc perfectly retractile.
Column destitute of suckers ... ... *Actinoloba.*
Column furnished with suckers ... ... *Sagartia.*
Column clothed with a rough epidermis ... *Phellia.*
Disc imperfectly retractile.
Base annular, parasitic on shells ... ... *Adamsia.*
Base entire, not parasitic ... ... *Gregoria.*
Tentacles mere warts; set in radiating bands ... ... *Discosoma.*

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* *Nemactis* (Actiniadæ) has also the column pierced.

Antheadæ.

Analyis of the genera.

Mouth normal.
- Tentacles not fully retractile.
  - Column long, trumpet-shaped ... ... *Aiptasia.*
  - Column normal.
    - Tentacles conical ... ... *Anthea.*
    - Tentacles fusiform ... ... *Eumenides.*
- Tentacles retractile.
  - Tentacles subulate.
    - Tentacles sub-equal ... ... *Paractis.*
    - Tentacles very unequal ... ... *Dysactis.*
  - Tentacles not subulate.
    - Tentacles club-shaped
      - Mouth elevated ... ... *Melactis*
      - Mouth depressed ... ... *Corynactis.*
    - Tentacles moniliform ... ... *Heteractis.*

Actiniadæ.

Analysis of the genera.

- Tentacles not retractile.
  - Column short and cylindrical ... ... *Comactis.*
  - Column long and conical ... ... *Ceratactis.*
- Tentacles retractile.
  - Skin smooth.
    - Column pierced ... ... *Nemactis.*
    - Column imperforate ... ... *Actinia.*
  - Skin warted ... ... *Phymactis.*

Bunodidæ.*

Analysis of the genera (after Gosse).

- Tubercles conspicuous.
  - Disc and tentacles retractile.
    - Tubercles of one kind only.
      - In the form of rounded warts.
        - Irregularly scattered ... ... *Tealia.*
        - Arranged in vertical lines ... ... *Bunodes.*
        - Arranged in wavy horizontal lines ... *Cereus.*
        - Arranged in a single horizontal line *Hormathia.*
      - In the form of pointed blisters ... ... *Cystactis.*
    - Tubercles of two kinds, viz., rounded warts and erectile pointed papillæ ... *Echinactis.*
  - Disc and tentacles not retractile ... ... *Bolocera.*
- Tubercles obsolete ... ... *Stomphia.*

* *Phymactis* (Actiniadæ) has also the column warted.

ILYANTHIDÆ.

Analysis of the genera (after Gosse).

Tentacles of one kind; marginal

Column thick, pear-shaped.

Mouth with a papillate gonidial tube ... *Peachia.*

Mouth simple ... ... *Ilyanthus.*

Column slender, long, worm-shaped

Invested with an epidermis ... ... *Edwardsia.*

Without an epidermis ... ... *Halcampa.*

Tentacles of two kinds; marginal and gular.

Naked; freely swimming ... ... *Arachnactis.*

Dwelling in a membranous tube; sedentary

Column inferiorly perforate ... ... *Cerianthus.*

Column inferiorly imperforate ... *Saccanthus.*

MINYADIDÆ.

Analysis of the genera (after Milne-Edwards.)

Tentacles simple.

Column smooth ... ... *Plotactis.*

Column warty ... ... *Minyas.*

Tentacles compound ... ... *Nautactis.*

Descriptions of the New Zealand Species.

PHYLLACTIDÆ.

Tentacles of two kinds; simple and compound.

Oulactis (M. Edwards).

Column with warts. Compound tentacles placed round the margin of the disc, and outside the simple tentacles.

Oulactis plicatus, sp. nov.

Column cylindrical, not much expanded at the base, about as high as broad; warts arranged vertically in numerous (80 or 100) rows. Brownish yellow, with the warts dirty white. *Disc* circular, concave; the margin, when expanded, thrown into five deep folds. Crimson, radiately streaked with yellow near the margin. The simple *tentacles* are conical, about two-thirds of an inch in length, and arranged in two rows. They are transparent, of a violet or greenish colour, and often with opaque whitish transverse bands on the interior aspect. The compound tentacles are in a single row, and about two-thirds the length of the simple tentacles. They are white, and multi-lobed, the lobes being subcylindrical and rounded at the ends.

Height about 2½ in. when extended. In rock-pools on the coast, near Dunedin.

The animal fastens pieces of broken shells, small stones, etc., to its column, and when retracted looks like a small heap of gravel. The compound tentacles are not sensitive. Its nearest ally is *Metridium muscosum* Drayton, from New South Wales, which Milne-Edwards and Haime have placed in their genus *Oulactis.* Occasionally some of the lobes of the compound tentacles are pink or orange.

Sagartiadæ.

All the tentacles simple. Column pierced with loop-holes.

Gregoria, Gosse.

Disc imperfectly retractile; column smooth, without suckers, perforated by a few large loop-holes.

Gregoria albocincta, sp. nov.

Column cylindrical, broader than high; yellowish-orange, vertically striped with yellowish-green, each band having a central line of darker green. *Disc* circular; reddish orange or brick red, radially streaked with darker; margin not beaded; *mouth* elevated, round; throat ribbed. *Tentacles* in four indistinct rows round the disc, short, about half the diameter of the disc, conical with blunt points, and often much swollen at the base. Their colour is opaque white. Diameter, about ·3 or ·4 of an inch.

Common in rock-pools near Dunedin. Sometimes the column is vertically streaked with red and white.

Antheadæ.

All the tentacles simple. Column imperforate, and smooth. Margin of disc not beaded.

Paractis, M. Edwards.

Column naked. *Tentacles* retractile, subulate, sub-equal.

Paractis monilifera.

Actinia monilifera, Drayton in Dana Expl. Exp., Zooph., p. 136.

Paractis monilifera, M. Ed., Corall. I., p. 248.

Column broader than high, dilated at both extremities, where the exterior surface has moniliform rugosities, of a pale brown with deeper lines. *Tentacles* longer than the disc, in three rows; ringed with brown and white. *Disc* yellowish.

Bay of Islands.

Anthea, Johnstone.

Column short, expanded at the base, surface wrinkled. No suckers, warts, nor loop-holes. *Tentacles* numerous, submarginal, scarcely retractile.

Anthea olivacea, sp. nov.

Column short, broad, and expanded at the base, slightly horizontally wrinkled; of an olive green colour down to the base. *Disc* circular, concave, with the mouth slightly raised; of a darker green than the column and

tentacles; *mouth* plaited, pink inside. *Tentacles* in four rows, much longer than the disc, tapering, not perfectly retractile, of the same colour as the column.

Diameter, about half an inch.

In rock pools near Dunedin.

In small specimens the tentacles are quite retractile.

There is also a variety in which the column is longitudinally streaked with yellow.

Actiniadæ.

All the tentacles simple. Column imperforate, smooth. Margin of the disc beaded.

Actinia, Linn.

Column short, much expanded at both ends, the margin separated by a broad but shallow fosse from the tentacles. Tentacles subequal, retractile.

Actinia (?) thomsoni.

Actinia thomsoni, Coughtrey, Trans. N.Z. Inst. VII., p. 280.

Port Chalmers.

I have not seen this species, and as Dr. Coughtrey has not mentioned any marginal beads, I doubt its being a true *Actinia*.

Actinia (?) striata.

Actinia striata, Quoy and Gaim., Voy. Astrol., IV., p. 164.

"Small, cylindrical, elongated; pale blue striated with reddish; *tentacles* numerous, acute, yellowish; *mouth* brownish yellow. Height, half an inch. Bay of Islands."

I have not seen this species, and cannot say to what genus it should be referred.

Phymactis, M. Edwards.

Column with suckers, but no loop-holes; margin of disc beaded.

Phymactis polydactyla, sp. nov.

Column short, cylindrical; suckers raised on warts, crowded at the upper part of the column, but arranged in vertical rows lower down; whitish, with the warts olivaceous brown. *Disc* circular, concave, of a deep crimson; a row of round white beads round the margin. *Tentacles* numerous, in three rows, conical, much shorter than the diameter of the disc; the exterior rows generally pink, the interior yellowish, or whitish, or greenish; sometimes with opaque white transverse bands interiorly.

Diameter, about one inch.

In rock pools near Dunedin.

Phymactis inconspicua, sp. nov.

Column cylindrical, as long or longer than broad, with vertical rows of suckers on warts. Olive brown above, passing into yellowish white below;

the warts brown, often pale-centred. Disc round, concave, olive brown, sometimes marked with grey, marginal row of beads white.

Tentacles moderate, nearly or quite equal to the diameter of the disc, quite retractile; olive brown margined with white, and often white-spotted.

Diameter about ·3 of an inch.

In rock pools near Dunedin, abundant.

In some the warts are obsolete near the base, owing to the animal having lived in a narrow crack in the rocks. There is also a variety in which the tentacles are purplish grey, and the disc even is sometimes the same colour.

Minyadidæ.

Base not adherent; lower extremity enclosing an air-chamber. Floating on the ocean.

Minyas, Cuvier.

Tentacles simple; column warty.

Minyas (?) *viridula.*

Actinia viridula, Quoy and Gaim., Voy. Astrol., IV., p. 161., pl. 13, f. 15-21.

Minyas ? *viridula*, M.Ed., Corall. I., p. 229.

Shape variable, discoid or elongated, longitudinally ribbed. Ribs twenty, tuberculated, and with a median row of white suckers. Mouth plicated. Greenish, mixed with bistre upon the ribs, and of a deeper green in the intervals.

Pacific Ocean, between New Zealand and the Friendly Islands.

Art. XXXIII.—*Catalogue of the hitherto described Worms of New Zealand.*

By Prof. F. W. Hutton.

[*Read before the Wellington Philosophical Society*, 10th *January* 1879.]

Class Turbellaria.

Unjointed, ciliated, leaf- or ribbon-like worms.

Order Rhabdocœla.

Intestine a simple pouch; pharynx protrusible or not; usually one sex-opening.

Genus *Chonostomum*, Schmarda.

Mouth central; pharynx infundibuliform; eyes two.

C. crenulatum, *Schmarda*, *Neue Wirbelloser Thiere* (1861).

Body oblong, subrounded, green. The two eyes purple. Pharynx infundibuliform, margin crenulated. Penis cirriform.

In still fresh water near Auckland.

Order Dendrocœla.

Intestine tree-like, aproctous; pharynx protrusible; body broad and flat; sex-openings double.

Genus *Polycelis*, Hemp. and Ehr.

Mouth subcentral; pharynx cylindrical. Eyes numerous, occasionally in a heap on the neck, also in lines on the margin.

P. AUSTRALIS, *Schmarda.*

Body flat, oblong-oval, brown; eye-clusters irregularly surrounded by a halo.

Auckland, and New South Wales. Marine.

Genus *Centrostomum*, Schmarda.

Mouth central, orbicular; pharynx multilobed, divided or crenated.

C. POLYSORUM, *Schmarda.*

Body oblongo-oval, truncated anteriorly; light brown; eye-clusters many.

Auckland.

Genus *Thysanozoon*, Grube.

With frontal pseudo-tentacles. Back with numerous papillæ. Eyes numerous.

T. cruciatum, Schmarda.

Body flat, elliptical. Papillæ conical. Two bands at right-angles to each other, destitute of papillæ. Eye-clusters cervical; two semi-circular.

Port Jackson and Auckland. Marine.

Genus *Geoplana*, Schultze.

Body long; mouth central; eyes numerous, anterior, and marginal. Terrestrial.

G. TRAVERSII, *Moseley. Q.J. of Micros. Science*, Vol. XVII., p. 284.

Body elongate, flat beneath, slightly convex above, bluntly-pointed posteriorly, more gradually attenuated anteriorly; broadest in the centre; generative aperture a little less than half the distance between the mouth and posterior extremity; ambulacral line absent, the whole under-surface acting as a sole; eye-spots forming a single row of ten or so on the front of the anterior extremity, and an elongate patch composed of two or three rows on the lateral margin of the body, just behind the anterior extremity; also present, sparsely scattered, on the lateral margins of the body for its entire length; body of a pale yellow on its lateral margins, with a broad mesial stripe on the dorsal surface, extending for its entire length, of a dark chocolate colour; and four narrow, ill-defined, and somewhat irregular similarly coloured stripes on either side of it, extending to the lateral margins of the body; under-surface, pale yellow.

Wellington.

Order NEMERTIDEA.

Long worm-like, mostly marine, diœcious, proboscis-bearing; body sometimes transversely striped.

Genus *Ommatoplea*, Ehrenberg.

Abranchiate; head entire; eyes many; proboscis terminal; mouth, subterminal; appendix none.

O. HETEROPHTHALMA, *Schmarda.*

Body depressed, tape-worm-like. Median line white, rest of the body red. Head indistinct, apex acuminate. Eyes in transverse lines.

Under stones on the shore, Auckland.

Genus *Meckelia*, Leuckart.

Respiratory fissures two, longitudinal. Eyes none. Proboscis terminal. Mouth subterminal.

M. MACROSTOMA, *Schmarda.*

Body depressed, greenish blue. Head attenuated. Fissures subterminal, short. Proboscis subterminal. Mouth oblongo-oval, very broad.

Auckland.

M. MACRORRHOCHMA, *Schmarda.*

Body rather flat, brownish olive. Head distinct, oblongo-lanceolate. Respiratory fissures as long as the mouth.

Shores of New Zealand.

Class GEPHYREA.

Body cylindrical, with a thick coriaceous skin, often indistinctly ringed. Head not distinct from the body, often produced into a proboscis.

Family *Sipunculidæ.*

Cylindrical, mouth at the tip of a retractile proboscis, surrounded with tentacles, and often with hooks; anus dorsal; teeth none.

Genus *Sipunculus*, Linnæus.

Skin netted with anastomosing muscular fibres; proboscis short, with simple tentacles.

S. ÆNEUS, *Baird, P.Z.S.*, 1868, *p.* 81.

Body cylindrical, slender, attenuated anteriorly, posteriorly thick, fusiform, reticulated, in the anterior portion corrugated, then smoother and minutely granulated; caudal apex oval, smooth, shining; proboscis short, smooth, the anterior portion thicker than the body; colour white, shining bronze. Length, 6½ in.; thickness of anterior part, 1½ lines; of posterior part, 4 lines; length of proboscis, 6 lines; thickness, 2 lines. New Zealand (Mr. Cuming).

Class ANNELIDA.

Body composed of numerous, more or less similar, segments; limbs none, or rudimentary; skin generally with chitinous bristles.

Order OLIGOCHÆTÆ.

Head rudimentary; no branchiæ; hermaphrodite; mostly land or fresh water.

Genus *Lumbricus*, Linnæus.

Setæ in four double rows.*

L. ULIGINOSUS, *Hutton, Trans. N.Z. Inst.* IX., *p.* 351, *pl.* VII., *f.* A.

Cephalic lobe large and rounded, completely dividing the buccal segment superiorly into two parts, and with a transverse sulcus on the posterior superior portion, between the divided halves of the buccal segment; anterior margin of buccal segment deeply emarginate inferiorly. Colour, reddish. Length, eight or nine inches.

L. CAMPESTRIS, *Hutton, Trans. N.Z. Inst.* IX., *p.* 351, *pl.* VII., *f.* B.

Cephalic lobe large, subconical, completely dividing the buccal segment superiorly into two parts; anterior margin of buccal segment entire, or slightly eroded inferiorly. Colour reddish, or olivaceous green, paler below. Length, two or three inches.

L. LEVIS, *Hutton, Trans. N.Z. Inst.* IX., *p.* 351., *pl.* VII., *f.* C.

Cephalic lobe small, conical, simple; anterior border of buccal segment slightly emarginate superiorly, entire inferiorly. Pale flesh colour or greenish. Length, three to four inches.

L. ANNULATUS, *Hutton, Trans. N.Z. Inst.*, IX., *p.* 352, *pl.* VII. *f.* D.

Cephalic lobe small and flattened, divided into anterior and posterior divisions inferiorly; anterior border of buccal segment emarginate superiorly, entire inferiorly; colour pale brownish-red, each segment with a dark reddish-brown transverse band in the centre, paler below. Length, about three inches.

Genus *Megasolex.*

Setæ in numerous rows all round the body.

M. ANTARCTICA, *Baird, P.L.S.*, XI., p. 96.

Body consisting of about 180 rings; setæ surrounding the body, short, black, rather distant; rings not keeled, larger and more distinct at the anterior extremity, closer at the posterior end, and all smooth. Length, seven inches.

M. SYLVESTRIS, *Hutton, Trans. N.Z. Inst.* IX., *p.* 352., *pl.* VII., *f.* E.

Cephalic lobe small flattened, with a deep transverse groove superiorly, and divided into anterior and posterior portions inferiorly; anterior border of buccal segment deeply excavated superiorly, entire inferiorly; setæ in about 30 double rows. Colour dark red-brown. Length, one and a-half to two inches.

M. LINEATUS, *Hutton, Trans. N.Z. Inst.*, IX., *p.* 352, *pl.* VII., *f.* F.

Cephalic lobe small, rounded, completely dividing the buccal segment superiorly into two parts; anterior border of buccal segment slightly

* L. *orthostichon* Schmarda, is stated to come from New Zealand by mistake; its proper habitat is Tasmania.

emarginate inferiorly; setæ minute in single rows; colour reddish-brown, finely longitudinally striated with lighter; length two inches.

Order Chætopoda.

Body not presenting distinct regions; branchiæ dorsal; sexes distinct; limbs tubular, setigerous. Marine.

Family Aphroditidæ.

Segments unequal, with dorsal, shield-like elytra; head lobes developed, with a single tentacle and lateral antennæ and palpi; eyes sessile or stalked; gills small, simple; epipharynx generally with two upper and two lower teeth and jaws.

Genus *Aphrodita*, Linnæus.

Head with three antennæ, two eyes, and a median caruncle or tubercle; buccal segment rudimentary without appendix; all the feet more or less covered with hairs, no barbed bristles; elytra 12-15 pairs alternating with the superior cirri; proboscis unarmed, or with rudimentary cartilaginous teeth.

A. talpa, *Quatrefages, Hist. Nat. des Annelés*, I., *p.* 196, *pl.* 6, *f.* 2.

Median tentacle very short, laterals long; body of 32 segments; feet enveloped in hairs; elytra 30, rounded, small; the whole back covered with dirty, brown hairs.

A. squamosa, *Quatrefages, l.c.* I., *p.* 201.

Head small, distinct, hidden by the prominent elytra; median antenna short, thick, truncated (?); laterals twice as long, slender; tentacles short; body of 27 segments, moderate, elongated; feet apparently one-oared, prominent; elytra 24, large, rugose, robust, covering the whole body; superior cirri longish, on a thick, compressed, swelling; hairs short, not covering the elytra; branchiæ more or less conical, and separated tubercles.

Genus *Polynoe*, Savigny.

Head distinct with 3 antennæ and 4 eyes; buccal ring indicated by the presence of two pairs of tentacles, the superior of which are bifurcate; the inferior longer, thicker, and simple. Feet more or less evidently biramous; the setigerous tubercles on a common peduncle; elytra alternating with the superior cirri of the feet, covering the whole length of the back; proboscis with two pairs of horny jaws.

P. aucklandica, *Schmarda, Neue Wirbelloser Thiere*, *p.* 158.

Body long, greyish-yellow; segments 60; tentacles 7; elytra oblique, oval.

Auckland.

P. macrolepidata, *Schmarda, l.c.*, *p.* 155, *pl.* 36, *f.* 306.

Body flat, brown; elytra 15 pairs, large, oval, or suboval, greyish-

yellow, spotted with brown, margin fimbriated with conical spines. Tentacles smooth; dorsal cirri spinulose.

Auckland.

This species belongs to the genus *Antinoe* of Kinberg, in which the bases of the antennæ are fixed under the margin of the emarginated cephalic lobe, close to the tentacle.

P. POLYCHROMA, *Schmarda, l.c., p.* 153, *pl.* 36, *f.* 307.

Body flat, yellowish-red; elytra 12 pairs, oval, yellowish, spotted with greyish-blue or greyish-red on the inferior external margin. Tentacles and cirri smooth.

This species, and the next, belong to the genus *Lepidonotus* of Leach, in which the bases of the antennæ are produced from the anterior margin of the cephalic lobe.

P. SINCLAIRI, *Baird, P.L.S., Zoology,* VIII., *p.* 184.

Head lobe rather small; palpi stout white, setaceous, smooth; elytra 12 pairs, pale coloured, mottled with black; rounded, thin, covered all over with minute points, with some larger raised and rounded punctations intermixed; ciliated on outer margin. Back completely covered. Feet biramous; ventral branch the larger, with a fascicle of yellow bristles, stout, slightly curved at the point, and serrated a short distance below the apex. Dorsal branch small; bristles short, slender, sharp-pointed, and minutely serrated nearly their whole length. Dorsal cirri conical, setaceous, smooth; anal cirri rudimentary. Length, about 9 lines; breadth, 2 lines.

Genus *Pelogenia*, Schmarda.

Body vermiform, long; elytra in all the segments. Suctorial feet in the back and abdomen; oars biramous. Tentacles seven, their external bases coalescing.

P. ANTIPODA, *Schmarda, l. c., p.* 160.

Back convex, blackish in front, reddish-yellow behind. Abdomen ferruginous, with a deep median sulcus. Suctorial feet disposed in four systems on the abdomen; two at the margins of the sulcus, the others at the bases of the ventral cirri. Dorsal suctorial feet behind and between the elytra. Dorsal elytra hardly covering, brownish-red, the margins undulating. Setæ golden, articulated, the superior part longer than the inferior, thin; superiorly short and broad.

Family EUNICEIDÆ.

Rounded, long, flattened ventrally; head lobes notched in front, with 1–5 tentacles; several separate upper, and two, often united, lower jaws; feet simple with acicula. Living in sand-burrows.

Genus *Eunice*, Cuvier.

Head with two eyes, and five antennæ placed in a single transverse row; buccal segment with two tentacles; branchiæ pectinate, or laciniate, on one side; setæ composite, with short spoon-shaped appendage.

E. GAIMARDI, *Quatrefages, l.c.* I., *p.* 321.

Head moderately notched; antennæ apparently moniliform; buccal segment rather long; tentacles moderate, subarticulated; upper jaws slender, lower six-toothed; border of denticule undulated; labrum narrow, slightly notched; body composed of 120 segments; upper cirri of feet thick longish, the lower smaller; branchiæ 6-fimbriate.

E. AUSTRALIS, *Quatrefages, l.c.* I., *p.* 321.

Head short, broad, deeply notched; antennæ long, moniliform; buccal segment long. Tentacles longish, subarticulated. Upper jaws robust; lower 10-dentate; denticule toothed; body of 120-130 segments; upper cirri of feet thick and longish, the lower small, fixed to a thick base; branchiæ 7-fimbriate.

Genus *Notocirrhus*, Schmarda.

No eyes nor antennæ; feet with a superior cirrus and simple setæ, or the setæ simple and composite.

N. SPHÆROCEPHALUS, *Schmarda, l.c., p.* 116.

Head globose. Body rounded, ochraceous. Branchiæ (dorsal cirri) subcylindrical. Setæ few, two-haired, border fringed, apex short and with five uncinate spinules.

Family AMPHINOMIDÆ.

Angular or flat; segments equal, few; head small, usually with five tentacles; toothless; branchiæ dorsal comb- or tree-like; bristles hair-like serrate, not acicular; head lobes often compressed.

Genus *Chloëia*, Savigny.

Head with three antennæ, two eyes, and a caruncle; buccal segment with two tentacles. Body more or less oval, with two thick, short, cylindrical cirri at the posterior extremity. Feet biramous, the branches distinct. Branchiæ bipinnate, two on each segment, remote from the feet.

C. INERMIS, *Quatrefages, l.c.,* I., *p.* 389.

C. gegena (?), *Grube Beschr., neu. od. Wen. bek. ann., p.* 91.

Head small. Lateral antennæ about equal to the tentacles, median larger. Caruncle crested, broad, and with a narrow margin. Body oval, elongate. Setæ of both feet simple; branchiæ small.

C. SPECTABILIS, *Baird, P.L.S.,* X., *p.* 234.

Body rounded-fusiform, attenuated at each end, of about 34 segments. Colour pale, dotted all over with numerous small white round spots varying

in size. Caruncle long, narrow, extending over 4 or 5 segments. Ventral cirri white; dorsal cirri long and subulate, of a beautiful purple colour. Branchiæ simply branched. Bristles of both feet capillary, slender, and simple, those of the dorsal tuft longer and stouter than the ventral.

Family Nephthyidæ.

Body long, many-jointed; lateral feelers small; peristome without cirri, but with parapodia and papillæ in place of teeth.

Genus *Nephtys*, Cuvier.

Head small, with four small antennæ. Body terminated by one anal cirrus. Branches of feet separated; the superior carrying a cirriform branchia on its inferior border.

N. macroura *Schmarda, l.c., p.* 91. *Quat.*, I, *p.* 430.

Body prismatico-cylindrical, greyish-yellow. Head trapezoidal. Eyes large. Tentacles four, distinct; jaws two on a horny base. Branchiæ short; inferior lamellar process large. Ventral cirrus obsolete. Caudal cirrus filiform long.

Family Nereidæ.

Body long, with two anal cirri; head flat, small, with four eyes, two small middle and two large outer antennæ; peristome with eight feelers; epipharynx protrusible, with two large horizontally moveable jaws, armed with denticles; parapodia double, with acicula, and no hair-like bristles.

Genus *Nereis*, Lamarck.

Head with four eyes and four antennæ; latero-external antennæ very thick terminated by a small distinct joint; buccal segment very distinct with 4 pairs of subulate tentacles; proboscis short, divided into 3 regions, of which two are exsertile, always armed with two strong curved jaws, and generally with very small and numerous denticles; feet biramous; superior branch with two tongue-like accessory branchiæ, inferior branch with a single similar one; both branches with bristles and a cirrus.

N. robusta, *Quatrefages, l.c.* I., *p.* 544, *not of Kinberg.*

Head broad, elongated, anterior sulcus apparently bipartite; lateral antennæ very thick, broad, shorter than the head; the median small, conical; buccal segment short. Tentacles shorter than the head; jaws broad, internal margin straight, 5–6-dentate. Denticles numerous, large, disposed in balls; body broad, of 107 segments; feet very short, appendices rounded, each with a short cirrus.

N. pacifica, *Schmarda, l.c., p.* 107, *pl.* XXXI., *f.* 246. *Quat., l.c.*, I., *p.* 546, *not* N. pacifica, *Quat., from Peru.*

Back obscure green; belly greenish-yellow; segments 180; head rounded; external tentacles rounded, short; branchiæ and ventral cirri

shorter than the feet; jaws with short apices; teeth five, rounded, irregular.

Auckland.

Genus *Heteronereis*, Œrsted.

Head, body, and anterior feet like *Nereis*; posterior feet very different from the others, carrying a foliaceous lobe, and the bristles sometimes single, sometimes mixed.

H. australis, *Schmarda, l.c., p.* 101, *pl.* XXXI., *f.* 242. *Quat.* I., *p.* 577.

Body flat, 96-ringed; jaws tridentate; appendices of the feet tongue-shaped and leaf-like; branchiæ (dorsal cirri) longer than the feet; upper tubercle subglobose; green in front, yellow behind.

Family Glyceridæ.

Segments many-ringed; proboscis club-shaped, protrusible; bristles with acicula; branchiæ short or none.

Genus *Glycera*, Savigny.

Head small, conical. Branches of the feet approximated, on a common peduncle, bristles simple and composite, with two acicula in each branch. Proboscis with four hooked teeth, with no points.

G. ovigera, *Schmarda, l.c., p.* 95, *pl.* 30, *f.* 239. *Quat.* II., *p.* 188.

Body yellowish or brownish-green; bipartite segments of the jaws with a broad base, external process quadrangular, pedicelled; proboscis ringed at the base, with a double series of papillæ; branchiæ (dorsal cirri) short, conical; feet notched; pectiniform ovaria at the base of the feet.

The body of this species is greenish, the feet yellow.

Family Phyllodocidæ.

Body long, many-jointed; head lobes small; antennæ 4 or 5; eyes 2-4; epipharynx with papillæ; ventral cirri leaf-like.

Genus *Eulalia*, Savigny.

Head with five antennæ and two or four eyes; buccal segment simple, double or triple, with four pairs of tentacles; body long, linear, narrow, always composed of a large number of rings; feet one-branched, armed with composite bristles, generally with a leaf-like cirrus.

E. cæca, *Quatrefages, l.c.*, II., *p.* 123.

Head small, rounded; antennæ small, the median behind; eyes none (?); buccal segment triple; tentacles very short, thick, disposed 1,2,1 on each side; body roundish, of 250–270 segments; feet small, exposed; upper cirri thick, hardly leaf-like, small, lanceolate; lower small mamillæform; bristles simple, short, straight, deciduous.

This very common species is of a dark green colour—(F.W.H.)

Genus *Porroa*, Quatrefages.

Head with five antennæ; buccal segment with only two tentacles.

P. MICROPHYLLA, *Schmarda, l.c., p.* 86, *pl.* 29, *f.* 230. *Quat.* II., *p.* 128.

Back very convex, blackish green; branchiæ rich green, small, ovalo-cordate; eyes four. Tentacles (antennæ) two frontal, two lateral, dissimilar, cervical. Tentacles two; ventral cirri tubercular.

Family SYLLIDÆ.

Body elongated; head with tentacles, often with eyes; peristome with 2–4 cirri, often united to the prostomium; pharynx not protrusible, sometimes toothed, or with a chitinous tube, which bears a boring spine; feet one-branched, with two aciculate bristle clusters; ventral cirri short or none.

Genus *Sph rosyllis*, Quatrefages.

Head not distinct from the buccal segment, with two frontal lobes, five antennæ or tentacles, and eyes.

S. MACRURA, *Schmarda, l.c., p.* 70 (Syllis). *Quat., l.c.* II., *p.* 53.

Body yellowish, convex above; below flat; frontal lobes conical; eyes four, disposed in a trapezium; branchiæ (upper cirri) short; 30 articulated.

Family CIRRHATULIDÆ.

Body rounded, fusiform; head with no teeth, antennæ, nor tentacles; feet in two series, on the lower hooks; thread-like gills on many of the segments.

Genus *Cirratulus*, Lamarck.

Head conic, mouth inferior; body cylindrical; first and last segments only without branchiæ.

C. ANCHYLOCHÆTUS, *Schmarda, l.c., p.* 58. *Quat.*, I., *p.* 458.

Body ochraceous; branchiæ red; back convex, belly flat; sides narrow, angulated.

Order CEPHALOBRANCHIATA.

Worm-like marine animals, mostly protected by a tube; body presenting distinct regions; respiration by branchiæ placed near or on the head. Sexes distinct; no teeth, nor epipharynx.

Family PHERUSIDÆ.

Free; peristome without bristles; branchiæ of simple threads surrounded by a girdle of long, yellow, thick bristles; segments not ringed; feet with upper linear and lower hook-like bristles; sometimes with terminal suckers.

Genus *Chlorœma*, Dujardin.

Mouth subterminal, placed between the two antennæ; body elongated, fusiform, covered with long hairs.

C. BICOLOR, *Schmarda, l.c., p.* 21, *pl.* 20, *f.* 169. *Quat., l.c., I., p.* 477.

Segments 50; body rounded, attenuated behind, greyish-yellow, anterior portion blue; the whole surface covered with a hyaline jelly; upper bundles of bristles 4-haired; the lower with hooked setæ.

Genus *Siphonostomum*, Grube.

Head distinct; body naked, attenuated behind; feet with simple bristles on both feet.

S. ANTARCTICUM, *Baird, P.L.S.*, XI., *p.* 95.

Setæ surrounding the head numerous, very short and fine; branchiæ short, numerous; body covered with an enveloping substance like that of most of the known species (shaggy). Setæ of the inferior ramus of feet single, crooked or hooked at the point, and of nearly a black colour. Colour of body varying from a very dark to a light brown, and of a transparent look. Length of longest specimen nearly three inches.

Family HERMELLIDÆ.

Tubiculous; segments of two or three kinds, the hinder thread-like with no appendages; head lobes fleshy, with a circlet of yellow paleæ on the prostomial border, which acts as an operculum; tube built up of cemented shells.

Genus *Pallasia*, Quatrefages.

Tentacles joined upon the upper face; operculum formed by two concentric rows of setæ; body divided into three regions.

P. QUADRICORNIS, *Schmarda, l.c., p.* 25, *pl.* 20, *f.* 174 (Hermella). *Quat., l.c.,* II., *p.* 324.

Body reddish-yellow; head and branchiæ violet; dorsal branchiæ blue; papillæ short; external paleæ aculeate at the sides; internal geniculate, aculeate; occipital spines four.

Family TEREBELLIDÆ.

Inhabiting soft, fragile tubes; body with two distinct regions; head without paleæ and lobes, but with large, moveable, ciliated, branchiæ, serving as touch- and prehensile-organs.

Genus *Terebella*, Linnæus.

Three pairs of arborescent branchiæ.

T. PLAGIOSTOMA, *Schmarda, l.c., p.* 41, *pl.* 24, *f.* 196. *Quat., l.c.,* II., *p.* 366.

Body reddish-yellow; cephalic branchiæ pale, short; laterals cinnabar-red, short; pinnulæ in the last segment; mouth transverse.

T. HETEROBRANCHIA, *Schmarda, l.c., p.* 42, *pl.* 24, *f.* 197. *Quat., l.c.,* II., *p.* 366.

Body yellowish-grey; cephalic branchiæ clear; first lateral branchia, consisting of many equal branches, the others with one branch longer; mouth obsolete quadrangular; pinnulæ.

Family SABELLIDÆ.

Tubiculous; body with two distinct regions; cephalic branchiæ pinnate, in two circlets or spirals, one of which may be rudimentary.

Genus *Sabella*, Savigny.

Head indistinct; branchiæ equal, more or less fan-shaped; anterior region not very distinct, scarcely broader than the posterior region; tubes membranous, open at one end only.

S. ARMATA, *Quatrefages, l.c.*, II., *p.* 453.

Head indistinct; branchiæ short, base produced into 22 free cirri; antennæ two pairs; collar dilated, six-lobed; anterior body segments light; setæ dissimilar, uncinate and crested.

S. CERATODAULA, *Schmarda, l.c., p.* 33, *pl.* 22, *f.* 186. *Quat., l.c.*, II., *p.* 459.

Branchiæ hardly one-fourth the length of the body, striped with yellow and brown; body brownish-yellow.

S. GRANDIS, *Baird, P.L.S.*, XIII., *p.* 160.

Collar rather broad, and deeply bilobed; thoracic feet seven pairs; segments belonging to them smooth, not grooved on the upper dorsal surface; back dark brown, rather yellow underneath; feet numerous, about 100. Peduncles large, well developed; anterior and posterior divisions separated by a groove, in the centre of which are situated the feet; a deep groove along the dorsal surface, except the seven thoracic segments; setæ short, slender, smooth, setaceous, sharp-pointed. Length, without branchiæ 6½ inches. Case, a leathery-looking tube, covered externally with a thin coat of mud.

Family SERPULIDÆ.

Tubiculous; two ciliated skin-folds on the front segments; branchiæ with a spiral basis, with one or two opercula with chitinous or calcareous discs. Tubes calcareous, attached to stones, etc., or free.

Genus *Serpula*, Linnæus.

A single cartilaginous or horny operculum; base of the branchiæ circular. Tube calcareous, fixed.

S. ANTARCTICA, *Quatrefages, l.c.*, II., *p.* 503 (1865).

Branchiæ short, cirri 24–25. Operculum infundibuliform, sub-concave, margin denticulated; body of 70–80 segments, anteriorly 7; anterior setæ filiform, rounded; laminæ denticulated; tube like that of *S. vermicularis.*

S. ZEALANDICA, *Baird, P.L.S.*, XI., *p.* 21, *pl.* II., *f.* 9 (1864).

Animal unknown; operculum white, small, sub-concave, margin with 20 denticulations; tube slender, white, creeping, nearly round, longitudinal, dorsal keel small, transversely flexuously striated.

Probably the same as the last (F.W.H.)

S. (Eupomatus) boltoni, *Baird, P.L.S.*, XI., *p.* 12, *pl.* I., *f.* 2.

Animal unknown. Operculum horny, infundibuliform, external margin densely crenated, internally with 20 calcareous pointed teeth. Tube red, three-angled, adherent, transversely rugose, back canaliculated.

Genus *Vermilia*, Lamarck.

A single operculum terminated by a calcareous plate, conical, or with various appendages; base of the branchiæ circular; tube calcareous, fixed.

Sub-genus *Placostegus*, Philippi.

Operculum terminated by a calcareous, disc-like plate, with an entire margin.

V. cariniferus, *Gray. Dieffenbach's New Zealand*, II., *p.* 242.
(Vermitus), *Baird, P.L.S.*, XI., *p.* 12.

Tube thick, irregularly twisted, opaque white, with a high compressed wavy keel along the upper edge; mouth orbicular, with a tooth above it, formed by the keel; operculum orbicular, horny. (Gray).

The whole animal is of a fine blue colour, and the elegant tuft of branchial filaments intensely azure, banded with white. (Baird).

V. cærulea, *Schmarda, l.c., p.* 29, *pl.* 21, *f.* 178. *Quat., l.c.*, II., *p.* 512.

Tube trigonal, blueish; operculum clavate, border smooth. Peduncles short, irregularly three-sided.

New Zealand and the Cape of Good Hope.

No doubt the same as the last (F.W.H.)

V. greyi, *Quatrefages, l.c.*, II., *p.* 510.

Branchiæ short, cirri 24–26; operculum sub-infundibuliform, flat, roughish; body 70–80-ringed; anterior setæ rather short, curved, slightly margined; laminæ striate; tube rough, keeled; aperture wide and obtusely dentated.

Sub-genus *Podioceros*, Quatrefages.

Operculum terminated by a flat surface, calcareous or cartilaginous, carrying a large number of short thick spines.

V. mahoria, *Quatrefages, l.c.* II., *p.* 520.

Branchiæ very short; cirri 20; operculum margined, bidentate behind; body of 50–60 rings, anteriorly 7; anterior setæ curved, fringed; laminæ obtusely denticulated. Tube like that of *V. greyi*.

V. strigiceps, *Morch, Rev. Serp., p.* 66. *Quat. l.c.* II., *p.* 521.

Operculum orbicular, flat; tube agglomerated, creeping, trigonal; dorsal keel compressed, acute, laciniated, beaked, with a series of punctiform impressions on either side; laterally convex; lines of growth often laminated, crowded.

North Australia and New Zealand.

Sub-genus *Vermilia*, Lamarck.

Operculum terminated by a calcareous prolongment, generally in the form of a simple cone, entire or truncated.

V. hombroni, *Quatrefages, l.c.* II., *p.* 527.

Branchiæ short, cirri 28 ; apex of the operculum irregularly spiroœform ; body of 40–50 rings, anteriorly 7 ; setæ elongated, curved, fringed ; laminæ serrated. Tube unknown.

Sub-genus *Galeolaria*, Lamarck.

Operculum terminated by a calcareous plate more or less flat, often composed of several juxtaposed pieces, carrying a large number of variously shaped spines, delicate, and elongate, disposed either on the circumference or on a more or less considerable tract of the operculum.

V. hystrix, *Morch, Rev. Serp., p.* 24, *pl.* 21, *f.* 3, 4. *Quat., l.c.*, II., *p.* 534.

Bottom of operculum excentric, anterior border sloping, composed of eleven diverging pieces, posterior border erect, composed of hexagonal pieces, bearing externally a long spine, from whence the surface of the operculum is hidden by crowded prostrate spines. Spines subulate, the upper layer ornamented with about 20 scales. The rest naked, apices slightly bent. Tube sub-solitary, creeping, above with two approximated keels, often vanishing towards the aperture ; lines of growth strong, unequal ; aperture circular, entire.

Genus *Cymospira*, Blainville.

Operculum single, corneo-calcareous, more or less complicated ; base of the branchiæ spiral ; horny laminæ instead of uncini.

C. incompleta, *Quatrefages, l.c.*, II., *p.* 543.

Head indistinct ; branchial cirri very numerous, on a quinquespiral base ; operculum (?) ; collar large, trilobed ; body with about 100 rings, anteriorly seven ; anterior setæ large, fringed, curved ; laminæ finely crenulated.

Genus *Spirorbis*, Daudin.

Basal leaves of the branchiæ rolled in a circle or semi-circle ; one or two opercula, not united together when two ; tubes generally isolated, entirely attached, twisted into a flat or nearly flat spiral.

S. zelandica, *Gray. Dieffenbach's New Zealand*, II., *p.* 295.

Tube reversed, whorls two or three, rapidly enlarging ; the last with three spiral ridges, the middle rib most prominent.

ART. XXXIV.—*List of the New Zealand* Cirripedia *in the Otago Museum.*
By Prof. F. W. HUTTON.

[*Read before the Otago Institute, 8th October,* 1878.]

1. BALANUS DECORUS, Darwin, Monograph of the sub-class Cirripedia, Balanidæ, p. 212, pl. 2, f. 6.
Dunedin, generally attached to the peduncle of *Boltenia*. The Museum also contains specimens from South Australia.

2. BALANUS AMPHITRITE, var. *variegatus*, Darwin, l.c., p. 240, pl. 5, f. 2.
Dunedin, on seaweed and shells.

3. BALANUS PORCATUS, Da Costa. Darwin, l.c., p. 256, pl. 6, f. 4.
Campbell Island, on rocks.

4. BALANUS VESTITUS, Darwin, l.c., p. 286, pl. 8, f. 3.
Stewart Island, on shells.

5. TETRACLITA PURPURASCENS, Wood. Dana, l.c., p. 337, pl. 11, f. 1*b*.
Wellington and *The Bluff*, on rocks.

All the New Zealand specimens that I have seen are like fig. 1*b* of Darwin, which is probably the *Conia depressa* of Gray (Dieffenbach's New Zealand, II., p. 269). The Museum also contains specimens from Sydney, which are like fig. 1*a* of Darwin, as well as some like fig. 1*b*.

6. ELMINIUS MODESTUS, Darwin, l.c., p. 350, pl. 12, f. 1.
Auckland, on rocks, abundant.

7. ELMINIUS SINUATUS, sp. nov.

Smooth, conical or depressed; parietes of each valve with two broad rounded folds, and faint transverse striations; white; sutures always distinctly defined. *Scuta* with the occludent margin smooth; adductor ridge obsolete; basal margin longer than the tergal margin. *Terga* with a long spur continuous with the scutal margin; crest for depressor muscle prominent and rounded.

Wellington, on shells.

Although the opercular valves are almost identical with those of *E. modestus*, the wall valves are so different and so constant that I cannot doubt the distinctness of the two species.

8. ELMINIUS PLICATUS, Gray. Dieffenbach's New Zealand, II., p. 269; Darwin, l.c., p. 351, pl. 12, f. 2.
Auckland and *Dunedin*, on rocks, abundant.

9. ELMINIUS RUGOSUS, sp. nov.

Rugged, deeply folded, the folds of the parietes often meeting and growing together, conical, sutures only distinct in young shells.

Dirty white or greyish. *Scuta* with a prominent adductor ridge; the articular furrow deep and strongly grooved; basal margin larger than the tergal margin. *Terga* stout, the articular ridge straight; carinal and basal margins confluent; spur short and broad.

The Bluff, on rocks, not common.

Distinguished from all varieties of *E. plicatus* by the straight articular ridge.

10. CORONULA DIADEMA, L. Darwin, l.c., p. 417, pl. 15, f. 3.
Waikouaiti, on a whale.

There are also in the Museum specimens from South Australia and Sydney.

11. CHAMÆSIPHO COLUMNA, Spengler. Darwin, l.c., p. 470, pl. 19, f. 3.
Dunedin, on rocks and shells, abundant.

There are also in the Museum specimens from Sydney.

12. LEPAS HILLII, Leach. Darwin, l.c., *Lepadidæ*, p. 77, pl. 1, f. 2.
Wellington and *Dunedin*, on floating timber.

13. LEPAS PECTINATA, Spengler. Darwin, l.c., p. 85, pl. 1, f. 3.
Auckland, on *Spirula lævis*, common.

14. LEPAS AUSTRALIS, Darwin, l.c., p. 89, pl. 1, f. 5.
Dunedin, on sea-weed.

15. LEPAS FASCICULARIS, Ellis and Solander. Darwin l.c., p. 92, pl. 1, f. 6.
Dunedin, on seaweed, *North Cape* on *Velella pacifica*.

16. SCALPELLUM VILLOSUM, Leach. Darwin, l.c., p. 274, pl. 6, f. 8.
Dunedin, on rocks. Mr. R. Gillies. Mr. Darwin gives no certain habitat for this species.

17. POLLICIPES SPINOSUS, Quoy and Gaimard. Darwin, l.c., p. 324, pl. 7, f. 4.
Wellington and *Dunedin*, on rocks.

18. POLLICEPS DARWINI, sp. nov.

Capitulum with one or more whorls of valves under the rostrum. *Scuta* triangular, as broad as high, not reaching half-way up the terga. *Terga* oval, elongated, more than twice as long as broad. convex. *Carina* curved, internally deeply concave, reaching more than two-thirds of the length of the terga, and with its apex close to the terga. *Rostrum* short and broad, much less than half the length of the carina. Scales of the peduncle unequal and unsymmetrically arranged.

Dunedin, on rocks. Mr. A. Montgomery.

Easily distinguished from *P. spinosus* by the projection of the terga beyond the scuta, and from *P. sertus* by the short rostrum, and the short rostrum and the apex of the carina not projecting.

APPENDIX.

The following additional species are said to occur in New Zealand:—

Balanus trigonus, Darwin, l.c., p. 223.

Coronula balænaris, Gml. *L. balænaris*, Gray, in Dieffenbach's New Zealand, II., p. 269.

Tubicinella trachealis, Shaw. Gray, in Dieffenbach's New Zealand, II., p. 269.

Anatifa elongata, Quoy and Gaimard, Voy. Astrol. III., p. 635, pl. 93, f. 6. Darwin, l.c., p. 374.

Bay of Islands.

Anatifa tubulosa, Quoy and Gaimard, l.c., III., p. 643, pl. 93, f. 5. *Alepas tubulosa*, Darwin, l.c., p. 169.

Tolaga Bay, attached to a living *Palinurus*.

Pollicipes sertus, Darwin, l.c., p. 327.

ART XXXV.—*On a new Infusorian parasitic* on Patella argentea.

By Prof. F. W. HUTTON.

[*Read before the Otago Institute, 8th October*, 1878.]

LAST month, while investigating the structure of *Patella argentea*, Quoy and Gaimard, I discovered numerous specimens of an infusorian attached to the branchiæ, of which the following is a description:—

Body campanulate, naked, devoid of cilia, hyaline, highly contractile; sessile or subsessile; mouth surrounded by a spiral ring of rather coarse cilia, which are capable of being moved or held motionless at the will of the animal. Length, $\frac{1}{500}$ inch. These little animals were attached to all parts of the branchiæ, and closed up suddenly, in the manner of *Vorticella*, when touched by any foreign body.

The absence of a carapace and of a stalk would appear to put this species into *Trichoda*, Ehr., but the disposition of the cilia round the mouth precludes this; and I am inclined to regard it as a *Cothurnia*, in which the lorica has become obsolete owing to its commensual habits. I therefore propose to call it *Cothurnia patellæ*.

ART. XXXVI.—*Description of some new Slugs.* By Prof. F. W. HUTTON.

[*Read before the Otago Institute, 26th November*, 1878.]

LIMAX MOLESTUS.

Mantle short and flatly rounded behind, smooth and sub-concentrically wrinkled when alive, rugose and not wrinkled in spirit. Pulmonary opening in the posterior third of the mantle; back rounded behind the mantle, pointed and keeled posteriorly; body with irregular longitudinal rib-like protuberances; colour variable—greyish or reddish-brown variously marbled with dusky. Tentacles of the same colour as the back; foot yellowish-white. Length, about 1½ inches. Shell slightly concave. A rather common variety is quite black.

Dunedin, *Wellington*, etc. Abundant everywhere.

The radula has 33 rows of rachis teeth, and about 20 on each side of lateral teeth.

This species is closely allied to *L. agrestis* of Europe, but is larger, the keel is not oblique, the pulmonary opening is placed more posteriorly, and the ovo-testis is more elongated. In Dr. Knight's paper on the Bitentaculate Slug of New Zealand (Trans. Lin. Soc. XXII., p. 381) figures 8, 11, 12, and 15 belong to this species.

MILAX EMARGINATUS.

Mantle slightly shagreened, short and emarginate behind; pulmonary opening a little behind the centre. A depressed line runs from this opening forward over the back, and backward again to a point on the left side opposite the pulmonary opening. Back sharply keeled up to the mantle; body smooth, with depressed lines radiating from the mantle. Colour dark grey or olive above; foot and lower sides of the body yellowish-white. Length 1 inch. Shell small, nearly flat; length ·08 inch.

Dunedin; common in gardens, etc.

Distinguished from *M. antipodarum* by the shape of the mantle and smooth body. I have *M. antipodarum* from Wellington. The radula has 27 rows of rachis teeth, and about 25 on each side of lateral teeth. The transverse rows are curved, the convexity being in the direction of the apices of the teeth.

ARION INCOMMODUS.

Mantle rugose, short and rounded behind; pulmonary opening in front of the middle; back rounded, not pointed posteriorly; colour dark lead-grey, a lateral stripe on the mantle, and a longitudinal band on each side, black; sometimes the whole upper part of the body greyish black; foot yellow. Length 1 inch; shell rudimentary.

Dunedin. Not uncommon in gardens, etc.

This species has the form of *Geomalcus*, but the genital organs open below the pulmonary opening; the ovotestis is small and globular, the albumen gland very large; the penis is long, and, when retracted, lies across the renal organ; the spermatheca is large and flask-shaped; there is no prostate gland, and the retractor of the penis is attached to its anterior end.

The retractor muscles of the tentacles are two—one on each side, and the retractor of the buccal mass is quite distinct from them, and originates much further back, on the right side. The teeth are arranged in slightly arched transverse rows; they are 32·1·32 on each row. The central tooth has a cusp on each side; the other rachis-teeth a cusp only on the outer side; the laterals decrease in size outwards. The laterals change gradually into the rachis-teeth, but there are about 10 rachis and 22 lateral teeth on each side.

Janella papillata.

Like *J. bitentaculata*, but with small papillæ on the back, between the oblique grooves.

Wellington and *Dunedin*. On trees.

Konophora, gen. nov.

Like *Janella*, but the eye peduncles short and conical.

Konophora marmorea.

Body smooth, rounded above, scarcely distinct from the foot; tail rounded; back with a central groove with lateral branches sloping obliquely backward; colour blackish, marbled with pale brown on the back; an indistinct black lateral line; region round the pulmonary opening yellowish. Length, 1 inch.

Dunedin. In the bush.

I have only seen a single specimen, which was collected by Mr. F. J. Browne, Articulator to the Museum.

[Note.—Both *Limax cinereus* and *L. flavus* have been introduced into Dunedin, but at present they are rare.]

Art. XXXVII.—*On* Phalacrocorax carunculatus, *Gmelin*.

By Prof. F. W. Hutton.

[*Read before the Otago Institute, 10th September*, 1878.]

During his voyage with Captain Cook, in 1773, J. R. Forster described a shag, which he said was found in New Zealand and Terra del Fuego, under

the name of *Pelecanus carunculatus*, distinguished, among other things, by having red caruncles, or elevated papillæ, behind the nostrils.

Dr. Latham in his "General Synopsis of Birds,"* (1878), using the unpublished manuscripts and drawings of the Forsters, appears to have divided this species into two, which he called the carunculated shag and the tufted shag respectively.

Subsequently (1788) Gmelin, in editing Linnæus' "Systema Natura" took these two species out of Latham and named them *Pelecanus carunculatus* and *Pelecanus cirrata*, the last being Latham's "tufted shag." Both are said to come from New Zealand only. *P. carunculatus* is said to have the face naked and "carunculated red," and to be about 20 inches in length.†

P. cirratus is said to have the crown crested, the tail composed of fourteen feathers, and in length to be about 34 inches.

In 1828 Latham published his "General History of Birds," in which he adopts Gmelin's scientific names.

Graculus carunculatus is said to be about 30 inches in length, and to have the space between the bill and the eye much carunculated, and over the eye a tubercle much larger than the rest. It is said to be rare in Queen Charlotte Sound (New Zealand) and abundant in Staaten Land. *Graculus cirrhatus* is said to be 34 inches in length; no caruncles are mentioned, but the skin round the eye is said to be bare. Evidently following Gmelin doubtfully, he remarks—"tail rounded and said to have fourteen feathers." Queen Charlotte Sound is given as the only habitat.

Captain King, R.N., described in 1830 (P.Z.S., Part I., p. 30) under the name of *Phalacrocorax imperialis*, a shag, from the Straits of Magellan, which has the head crested. No mention is made of any caruncles, but the tail-feathers are said to be twelve in number. Brandt (Bull. Sci. Acad., Petersburg, 1837‡) not only gives all these three species, but adds another, *Carbo purpurascens*, from Chili and the Falkland Islands, characterised by the absence of any white on the wing-coverts.

Mr. G. Gray in the "Zoology of the Voyage of the Erebus and Terror" (1844) united Gmelin's two species under the name of *G. cirrhatus*, and said that *G. carunculatus* was the young, "wanting the crest, the long linear feathers over each eye, and the oblong spot on each wing." He gives *P. imperialis*, King, as a synonym of *P. cirrhatus*, Gmel.

Bonaparte in his "Conspectus Generum Avium" (1857) separates *cirrhatus* from *carunculatus*, and puts them in different genera, on account of the supposed difference in the number of the tail-feathers. *Hypoleucus*

* This book I have not seen.

† I take these from the edition of 1806. The length is probably a mistake for 30 inches.

‡ This publication I have not seen.

cirrhatus is said to come from Chili, to be 27 in. in length, and to have 14 feathers in the tail. *Leucocarbo caruncutatus* is also said to come from Chili and the Straits of Magellan. The base of the bill is said to be carunculated, and in the breeding season the bird is said to be crested, and to have a broad band of white on the back. He gives *P. imperialis*, King, as a synonym of *L. carunculatus.* Dr. Finsch says in 1870 (Jour. für Ornith., p. 375) that he has compared a specimen of *G. carunculatus*, Gm. from the Crozet Islands with those from the Straits of Magellan in the Leyden Museum, and finds them to belong to the same species. Dr. Buller in his Birds of New Zealand (1873) keeps both species together and gives *Carbo purpurascens*, Brandt, as another synonym. In 1874 Dr. Finsch (Jour. für Ornith., p. 213) having received a specimen from the Chatham Islands, again separates *P. carunculatus* from *P. cirrhatus*, pointing out that the South American birds have the gular and chin regions totally naked, while in the Chatham Island bird there is a central feathered strip, and the sides of the head and neck are dark. He considers the Chatham Island bird to be *G. carunculatus*, Gmel., and the Magellan Strait bird to be *G. cirrhatus*, Gmel.

Mr. R. B. Sharpe, in the appendix to the Birds of the "Zoology of the 'Erebus' and 'Terror'" (1875), accepts Dr. Finsch's views; but in the same year Dr. Coues (Bull. U.S. National Museum, No. 2) identifies the shag from Kerguelen's Land as *G. carunculatus*, although pointing out that it has no white band on the wing, and considers *G. cirrhatus* as a synonym. Dr. Kidder, in the same publication, remarks that in this bird the caruncles at the base of the bill are brilliant yellow.

Such, in short, is the history of the nomenclature of these birds. The first statement (Forster) was that there is one species found both in New Zealand and South America. Then (Gmelin) that there are two species, both found in New Zealand. Then (Latham) that there are two species, both found in New Zealand, and one of them *(carunculatus)* in South America also. Then (Gray) there is said to be only one species, inhabiting both places. Then (Bonaparte) there are said to be three species, all inhabiting South America. Then Dr. Buller again considers them all as one species, inhabiting both places. Then Dr. Finsch and Mr. Sharpe consider that there are two species—*G. carunculatus*, inhabiting New Zealand and the Chatham Islands, and *G. cirrhatus* inhabiting the Straits of Magellan and the Crozet Islands; at the same time Dr. Coues, who has probably never seen a specimen from New Zealand, thinks that there is only one species.

During a late visit to Melbourne I had, through the kindness of Prof. McCoy, the opportunity of examining a specimen in the Museum, named *P. cirrhatus*, from the Falkland Islands, and of comparing it with specimens

from Kerguelen's Land, the Chatham Islands, and New Zealand, in the Otago Museum, and I have no hesitation in confirming Dr. Finsch's opinion that there are two quite distinct species.

The Falkland Islands and the Kerguelen's Land birds have the gular pouch naked; the white of the throat extends over the sides of the upper part of the neck, and the caruncles at the base of the bill are large, projecting considerably above the line of the front, the two meeting, or nearly meeting, in the median line above the bill. In the Chatham Island and New Zealand birds, there is a band of white feathers along the centre of the gular pouch; the sides of the upper neck are dark, and the caruncles are reduced to small papillæ, which do not project above the line of the front, and are divided by the feathers of the front.

But, although it is easy to show that there are at least two species, it is not easy to say which name should be applied to each. Forster, no doubt, first described the New Zealand bird, and afterwards erroneously identified the South American bird with it, but it is doubtful whether he had applied the name *carunculatus* to the New Zealand bird before he had examined those in Terra del Fuego, and as his manuscripts were not published until 1844, it is immaterial for the present enquiry whether he did or not. Gmelin was the first to name the birds, and he gave the name *carunculatus* to the smaller carunculated bird without a crest, and *cirrhatus* to the larger and crested bird.* Gmelin says that both birds come from New Zealand only, but he took his birds from Latham, and Latham says that *cirrhatus* occurs in New Zealand only, while *carunculatus* is rare in New Zealand, and common in South America. The smaller size, the caruncles, and the locality would all point to *carunculatus* as the South American bird, but, on the other hand, the New Zealand bird appears never to get a crest.

Dr. Kidder gives the length of a Kerguelen's Land bird at 23½ in.; the specimen in the Otago Museum is rather larger. Dr. Buller gives the length of birds from New Zealand as 32 in., and of birds from the Chatham Islands at 26 in. (Trans. N.Z. Inst., IX., p. 339). The Chatham Island birds are evidently smaller than those from New Zealand, but neither Latham, Gmelin, Brandt, nor Bonaparte had seen birds from the Chatham Islands. Brandt or Bonaparte appear to be the first to state that both species came from South America, and when Dr. Finsch had to transfer one back again to New Zealand, he took *carunculatus*. The evidence is, however, I think, in favour of the New Zealand bird being *cirrhatus*; and, as the Magellan Straits bird truly merits the name *carunculatus*, while the New Zealand bird does not, I think it would be better to change Dr. Finsch's nomenclature.

* The number of tail-feathers can be omitted, as both species have 12 tail-feathers.

The idea that the South American bird is *P. cirrhatus* was probably stated by Mr. Gray, who no doubt had seen Captain King's specimens, giving *P. imperialis*, King, as a synonym of *P. cirrhatus*, Gml.; but Mr. Gray included *P. carunculatus* with *P. cirrhatus*, and Bonaparte gives *imperialis* as a synonym of *P. carunculatus*, Gml.

The synonomy will therefore be as follows:—

PHALACROCORAX CARUNCULATUS.

Carunculated Shag, Latham (1775).
Pelecanus carunculatus, Gmelin (1778). Habitat wrong.
Graculus carunculatus, Latham (1828).
Phalacrocorax imperialis, King (1830).
Carbo carunculatus, Brandt (1837).
Carbo purpurascens, Brandt (1837).
Leucocarbo carunculatus, Bonaparte (1857).
Leucocarbo purpurascens, Bonaparte (1857).
Graculus carunculatus, Finsch (1870).
Graculus carunculatus, Hutton (Cat. Birds of New Zealand, 1872, ex Layard) Hab. wrong.
Graculus cirrhatus, Finsch (1874).
Graculus carunculatus, Coues (1875).

Hab.: Straits of Magellan, Falkland Islands, Crozet Islands, Kerguelen's Land.

PHALACROCORAX CIRRHATUS.

Tufted Shag, Latham (1775).
Pelecanus cirrhatus, Gmelin (1778).
Graculus cirrhatus, Latham (1828).
Carbo cirrhatus, Brandt (1837).
Graculus cirrhatus, Gray (1844).
Hypoleucus cirrhatus, Bonaparte (1857). Habitat wrong.
Phalacrocorax carunculatus, Buller (1873).
Graculus carunculatus, Finsch (1874).
Graculus carunculatus, Sharpe (1875).

Hab.: New Zealand and the Chatham Islands.

The next question is, are there more than two species? The Kerguelen's Land birds differ from those of South America in having no white bar on the wing, and in the caruncle being yellow instead of crimson. If constant these differences are sufficient to distinguish the Kerguelen's Land species, to which the name of *P. purpurascens*, Brandt, should be applied, unless that is only the immature *P. carunculatus*, which is most likely.

Dr. Buller has also suggested (Trans. N.Z. Inst. IX., p. 338) that *P. cirrhatus* may possibly include two species, the birds of the Chatham Islands being distinguished from those of New Zealand by being smaller and crested, and he formerly proposed to call the New Zealand bird *P. finschi*, but found that that name had been appropriated by Mr. Sharpe.

The statement that the Chatham Island birds are crested, while the New Zealand birds are not, must be taken with caution. I have certainly never seen a crested bird from New Zealand myself, but they are very rare, and I have not seen many; and *P. cirrhatus* appears to have been founded on a crested bird from New Zealand. The bird also appears to be scarce in the Chatham Islands, for although Dr. Buller quotes Mr. H. Travers as saying that "he met with *P. carunculatus* in large numbers in the Chatham Islands" (l.c., IX., p. 339), Mr. Travers himself states that it is "not common" (l.c., V., p. 221), and the specimen sent to Dr. Finsch from the Chatham Islands was not crested. Consequently the question as to the crest must be considered as unsettled. However, it appears that the Chatham Island birds are decidedly smaller than those from New Zealand; but if Dr. Buller decides on considering this difference as of specific value, it is to the Chatham Island bird that he must apply the new name, and not as he supposes to the New Zealand bird.

DIMENSIONS OF THE THREE SPECIMENS IN THE OTAGO MUSEUM.

	Kerguelen's Land. Crested.	Chatham Islands. Crested.	Otago. Not crested.
Wing	11·5	11·5	12·5
Tail	5·5	5·5	6·0
Bill (culmen)	2·25	2·5	2·8
Tarsus	2·0	2·0	2·4
Outer toe and claw	4·25	4·3	5·0

ART. XXXVIII.—*Notes on a Collection from the Auckland Islands and Campbell Island.* By Prof. F. W. HUTTON.

[*Read before the Otago Institute, 10th September*, 1878.]

LAST June, Captain Townsend, R.N., was kind enough to agree to take Mr. E. Jennings, taxidermist to the Museum, to the Auckland and Campbell Islands in H.M.S. Nymphe, in order that he might collect specimens of natural history for the Museum. The Nymphe arrived at Port Ross on 13th June, 1878, and left again on the 17th, but as the 16th was Sunday, Mr. Jennings only had two days and a half for collecting. On the 19th they arrived at Campbell Island and left again the same day, Mr. Jennings going on shore for an hour and a half only. It was during these short times that the collections referred to in these notes were made.

No seals were seen during the trip.

BIRDS.

Anthornis melanura, Sparrm.

A single male individual from the Auckland Islands, which in colour quite resembles specimens from New Zealand. The following are its dimensions in inches:—Length 8·5, wing 3·6, tail 3·5, culmen ·57, tarsus 1·3, outer toe (without claw) ·55, middle toe ·7, inner toe ·45, hind toe ·47.

Phalacrocorax magellanicus, Gml.

Head, neck, back, rump, thighs and upper tail-coverts blue-black; shoulders, scapulars and wing-coverts green-black, except a very narrow bar of white formed by some of the upper wing-coverts; chin, throat, and whole under surface of body, except the neck, white, wings and tail brownish-black. Head crested, a few linear white feathers above the eye and on the upper part of the neck. Irides brown. Skin in front of the eyes dark blue, the minute papillæ crimson, sparingly clothed with small feathers. Bill dark brown passing into orange at the base of both mandibles, gular skin bright orange. Legs and feet flesh-colour, with the soles and the joints on the upper surface black; webs flesh-colour shading into black towards the margin. A narrow strip of white feathers runs along the centre of the chin pouch.

Immature.—The whole of the upper surface, neck, wings and tail dark brown, in places glossed with greenish, no white alar bar; chin, throat and belly white. Skin before the eye dull orange with crimson spots; bill brown passing into orange at the base of the mandibles, gular pouch orange. Feet as in the adult, but not so pink.

Length 28 inches, extent 39, wing 10·5, tail 6, culmen 2·2, bill to gape 3·1, depth at nostrils ·52, breadth ·43, tarsus 2·4; outer toe (without claw) 3·8, middle toe 2·85, inner toe 1·85, hind toe 1·25.

Two individuals, both females, from Campbell Island.

This species is allied to *P. carunculatus*, but is at once recognised by its black neck. The white alar band is also much smaller.

Stercorarius antarcticus, Lesson.

A single female from Campbell Island.

Larus dominicanus, Licht.

A young female from Campbell Island.

Larus scopulinus, Forster.

Three specimens from the Auckland Islands and three from Campbell Island.

Five of these birds are adult (four males and one female) and all have the breast beautifully tinged with rose colour, as is often the case with *Sterna frontalis.* I have never seen this colouring in the New Zealand gulls.

Fishes.

Notothenia angustata, Hutton, T.N.Z.I., 1875, p. 213.

Five specimens of this fish were brought from the Auckland Islands. It may be identical with *N. maoriensis* Haast, T.N.Z.I., 1872, p. 276; but that species is said to have only three spines in the first dorsal, and to have scales below the eyes. It is no doubt the same as *N. coriiceps* of the "Fishes of New Zealand" (1872), and most probably Sir J. Richardson confused it with his *N. coriiceps* in the Ichthyology of the Voyage of the "Erebus" and "Terror." The type of *N. coriiceps*, according to Dr. Günther, comes from Kerguelen's Land.

Notothenia arguta, sp. nov.

B. 5; D. 4 | 30; A. 24; L. lat. 52.

Height of the body goes 4¼ times into the total length; length of the head four times; posterior limb of the preoperculum perpendicular; top of the head flat, not concave, scaleless, roughened with small rounded papillæ; above purplish black, lighter and pinkish below; gill membrane marked with orange. A single specimen 7¼ inches in length from Campbell Island. In general shape it approaches *N. microlepidota*, but is easily distinguished by the fin formula.

Notothenia microlepidota, Hutton, T.N.Z.I., 1875, p. 213.

D. 7 | 27; A. 22.

Two specimens from the Auckland Islands.

Notothenia parva, sp. nov.

B. 6; D. 6 | 28–29; A. 23–25; L. lat. 62.

Height of the body goes 5½ times into the total length; length of the head five times; top of the head scaleless, flat, with scattered papillæ. Colour, greenish-black, belly white, vertical fins black.

Four specimens from the Auckland Islands; 3 to 3½ inches in length.

This species approaches *N. sima*, but has no scales on the top of the head, and differs in its fin formula.

Tripterygium jenningsi. sp. nov.

D. 6 | 20–21 | 15–16; A. 28.

A simple tentacle above the orbit, and another at the nostril; teeth on the vomer, none on the palate. Colour, very variable; greenish-brown, reddish-brown, or black, marbled with darker.

Sixteen specimens from the Auckland Islands, the largest 3½ inches in length.

The lateral line is as in *T. nigripenne*, to which species it is closely allied, but differs in having constantly 28 rays in the anal fin.

Note.—*Notothenia arguta*, *N. parva* and *Tripterygium jenningsi* were taken

in rock pools, *N. angustata* and *N. microlepidota* in a net. Not a single fish was caught with a hook. Most of the fish at the Auckland Islands are attacked by parasites in a most remarkable way; in some cases the whole of the lateral muscles being full of a round worm about an inch in length. So bad are they that nothing but sheer necessity would induce any one to eat fish at these islands.

CRUSTACEA.

Prionorhynchus edwardsii, Jacq. and Lucas.

Six specimens from the Auckland Islands, all male.

Nectocarcinus antarcticus, Jacq. and Lucas.

Six specimens from the Auckland Islands, of which five were obtained from the stomach of a large specimen of *Notothenia microlepidota.*

Halicarcinus planatus, Fabr.

A great many specimens from both the Auckland and Campbell Islands.

Munidia subrugosa, List.

Three specimens from the Auckland Islands; two adult and one young. The young specimen is quite as small or smaller than *Grimothea gregaria*, so abundant round the South Island in March, and yet it does not show the slightest approach to the foliaceous maxillipeds of *Grimothea.* The habits of the two species are also quite different. *Grimothea* is pelagic and floats on the surface of the sea, while *Munidia* lives at the bottom. Mr Jennings caught these specimens in a baited net.

Squilla lævis, sp. nov.

Rostral-plate semi-lanceolate, acute; carapace smooth, without crests, slightly expanded and rounded behind; inner antennæ reaching nearly as far as the outer, second joint extending as far as the eye, third joint as long as the second. Prehensile finger with 12 teeth (exclusive of the extremity); penultimate finely toothed internally and with three spines at the base; externally quite smooth; abdomen smooth, without longitudinal ridges, scarcely broader than the carapace, without lateral spines except on the penultimate segment; last segment with about 10 spines alternately large and small, while on each side of the central line there are six very small spines; internal lateral caudal plates oval, not passing the marginal spine of the basal joint. Length, 1¾ inch.

A single specimen taken from the stomach of a specimen of *Notothenia microlepidota*, caught at the Auckland Islands.

Cirolana rossii, List.

Many specimens from the Auckland Islands.

Sphæroma gigas, Leach.

Several specimens from the Auckland Islands.

Sphæroma obtusa, Dana.

A few specimens from Campbell Island, and two from the Auckland Islands.

Actæcia aucklandiæ, G. M. Thomson.

For a description of this species see Mr. Thomson's paper in the present volume of Transactions. (*Ante* p. 249.)

MOLLUSCA.

Euthria lineata, Chemnitz.

Many specimens from the Auckland Islands.

Euthria littorinoides, Reeve.

Two specimens from Campbell Island.

Polytropa striata, Martyn.

A single specimen from the Auckland Islands.

Diloma, sp.

Two specimens from the Auckland Islands. There are specimens of this species in the Museum from Campbell Island, presented by Dr. H. Filhol, who will doubtless describe it. It is something like *D. nigerrima*, but smaller, bluer, and not so depressed.

Cantharidus episcopus, Hombron and Jacquinot.

Several dead shells from the Auckland Islands. It is also in the Museum from Campbell Island.

Tectura pileopsis, Quoy and Gaimard.

Several specimens from the Auckland Islands.

Patella magellanica.

Several specimens from the Auckland Islands, and one or two from Campbell Island. I believe that *P. inconspicua*, Gray, is only a small variety of this species.

Patella redimiculum, Reeve.

Several specimens from the Auckland Islands.

Chiton circumvallatus, Reeve.

Several specimens from Campbell Island.

Chiton lineolatus, Frembly.

Several specimens from both the Auckland Islands and Campbell Island. It varies much from black to gaily painted. It is also found near Dunedin.

Chiton longicymba, Blainville.

A few specimens from the Auckland Islands. There are also in the Museum specimens from Campbell Island, presented by Dr. H. Filhol.

Plaxiphora biramosa, Quoy and Gaimard.

Two specimens from Campbell Island. When drying, this species often splits longitudinally.

Onchidium patelloides, Quoy and Gaimard.

Seven specimens from the Auckland Islands.

Siphonaria redimiculum, Reeve.

Four specimens from the Auckland Islands. This curious species will probably form the type of a new genus. It is of on olive brown outside and dark purple inside.

Mesodesma novæ-zealandiæ, Chemnitz.

A single specimen from the Auckland Islands.

Venus oblonga, Hanley.

A single specimen from the Auckland Islands.

Chione stutchburyi, Gray.

Eight specimens from the Auckland Islands.

Mytilus magellanicus, Lamarck.

A few specimens from both the Auckland Islands and Campbell Island.

Mytilus dunkeri, Reeve.

Several specimens from both the Auckland Islands and Campbell Island.

Note.—In addition to the foregoing there are in the Otago Museum the following shells from the Auckland and Campbell Islands :—

Euthria bicincta, Hutton, Auckland Islands.
Neptunæa, sp., Auckland Islands.
Cominella maculata, Martyn, Auckland Islands.
Turbo granosus, Martyn, Auckland Islands.
Diloma æthiops, Gml., Auckland Islands.
Diloma nigerrima, Chemnitz, Auckland Islands.
Haliotis iris, Martyn, Auckland Islands.
Haliotis rugoso-plicata, Chemnitz, Auckland Islands.
Haliotis gibba, Philippi, Campbell Island.
Patella radians, Gml., Auckland Islands.
Patella imbricata, Reeve, Campbell Island.
Patella rubiginosa, Hutton, Auckland Islands.
Tapes intermedia, Quoy and Gaimard, Campbell Island.
Modiola areolata, Gould, Auckland Islands.
Terebratella rubicunda, Sow. ?, Auckland Islands,

ANNELIDA.

Several specimens of Chætopod worms from both the Auckland Islands and Campbell Island are in the collection, but they cannot be determined until the New Zealand Chætopods have been examined.

ECHINODERMATA.

Asterias rupicola, Verrill, Bull. U.S. National Museum, No. 3, p. 71.

var. *lævigatus*, Hutton.

Spines of the back obsolete.

Several specimens from the Auckland Islands.

I should have regarded this as a new species if one of the specimens had not shown a row of spines along the back and traces of a lateral row on each side, thus connecting the two forms.

ART. XXXIX.—*Note accompanying Specimens of the Black Rat* (Mus rattus, *L.*)

By TAYLOR WHITE, Esq., of Glengarrie, Napier.
Communicated by Prof. HUTTON.

[*Read before the Otago Institute, 26th November*, 1878.]

Two of the rats were caught in 1876 in a field of oats which I was cutting, eighteen miles from the shipping, and so might be called country rats. I think I killed four. The two kept were an old male and a young female not quite full grown. I have found no others since. The skin I picked up at Napier port, alongside the shipping.

It may be of some interest for me to state that the rats on the Canterbury plains in 1855 had regular warrens, and lived in communities. I have taken six and eight from one warren. The warren was not raised above the surface of the ground, but could be detected by the unusual greenness of the grass. There were a number of bolt holes within a circular radius of about four feet. At the time I was under the impression that they were ordinary rats; but not having seen this habit since or elsewhere, I now think that they must have been peculiar. In colour, I think, they resembled the common rat *(Mus decumanus)*. We used to dig them up for the fun of seeing the dogs catch them.

I was witness to the first migrations of the common mouse *(Mus musculus)* on three separate occasions. First, from about Christchurch to the plains at Oxford; second, from Oxford onwards over the first range of hills to country through which the Hokitika road now passes; and third, to the country bordering Lake Wakatipu. In all three places I lived a considerable time, and never saw such a thing as a mouse, but the rats were legion.

After a time the sight of the first mouse was reported as seen in the grass. In the course of a week the grass country and the houses were plentifully supplied. It is most remarkable that the rats immediately cleared out before them, and from that time were much scarcer.

In Otago, formerly, I used to kill a great number of rats living singly under plants of the Spaniard, the old leaves of which made them a nice thatched roof, and the root was eaten if nothing better offered. Once in the early days of settlement in Otago, when I was snowed in, and could get nothing to feed my fowls on, I caught large numbers of rats near the house (getting them from under the Spaniard bushes) and roasted them for the fowls. I noticed that the stomach of these rats was generally full of a white wire-like worm, about two inches long, which I considered a parasite, as they were always perfect; but, if I remember right, there was no appearance of other food in the stomach, and very little room for it, as the worms were knotted together into a mass that about filled the cavity.

Note by Prof. Hutton.

The skin from Napier belongs to *Mus rattus.* It agrees perfectly with the description of the specimen in the Colonial Museum, from Wellington, (Trans. N.Z. Inst., IV., p. 183), and with Dr. Buller's description of his *Mus novæ-zealandiæ* (Trans. N.Z. Inst., III., p. 1). The two specimens caught in the oat-field had been put into kerosene, and were not fit for stuffing. They both presented, externally, the same characters as the skin from Napier. I have examined these two skulls, and find that they agree with Mr. Salter's description of the skull of *M. rattus,* except in being smaller and more elongated. Consequently, they differ from the Maori rat skulls, from Shag Point, in the particulars that I have already pointed out.

There can, I think, be no doubt that these rats belong to the Polynesian variety of *Mus rattus,* and consequently the Maori rat must be regarded as a distinct species, for which I propose the name of *Mus maorium.*

The following are the measurements of the skull of the adult male specimen. I have added measurements of *M. rattus* from England (from Mr. Salter's drawings), and of *M. decumanus* from New Zealand :—

	M. rattus, Napier.	*M. rattus,* England.	*M. decumanus,* Dunedin.
Length	1·43	1·64	1·78
Width at zygomatic arch*	·59	·82	·75
Foramen magnum, height	·19	·14	·20
" " width	·25	·28	·28

* In the measurements of the skulls from Shag Point, the width at the zygomatic arch should be ·65, and not ·35 as printed.

ART. XL.—*On a new Species of* Millepora. By the Rev. J. E. TENISON-WOODS, F.L.S., F.G.S., Corr. Mem. Roy. Soc. Victoria, Tasmania, Linn. Soc. N.S.W.; Hon. Mem. Roy. Soc. N.S.W., Adelaide Phil. Soc., etc., etc. Communicated by Prof. HUTTON.

[*Read before the Otago Institute, 10th September*, 1878.]

THE specimen to which I have the honour to call the attention of the Society was sent to me by my friend Captain F. W. Hutton, of Otago, and was stated to have been found in Foveaux Strait; but the depth at which it occurred and its station were not stated. It is a tufted zoothome of highly reticulate structure, but hard and compact. It grows apparently in a solid mass, from which pencil-like cylindrical stones grow out vertically, to a height of two or three inches, but not more than a third of an inch in diameter. On examining the surface with the microscope, it is seen to be covered with minute rounded pores, which have an exact, thickened, very slightly raised margin. These pores are very close to one another, but there are interstices which are occupied by much smaller pores, which are in fact nothing but the polygonal spaces left between the closely-crowded tubes. When a fragment is broken across, two different kinds of structure are observed. One is a kind of outer ring, on which a radiate arrangement of the tubes is preserved, that is to say radiating from the axis to the circumference; the other is a central cancellous tissue, made up of tubes exactly like the surface, but the walls more delicate. The outer radiate ring of tubes is about one-fifth of the diameter; the remaining four-fifths is occupied by the central tissue. The latter is of different colour, or blueish white, while the outer ring is a reddish-brown. The tubes, which open on the outer surface, are not more than half a millimeter in depth, but it is not at first very clear whether they are closed by tapering to a point or whether they curve downwards or upwards, and so join the cancellous tissue or pith, as it might be termed, of the centre. The tubes of the centre seem to be continuous. A hair can be easily passed down them for half an inch or more. When a section is made it is then clearly seen that the tubes curve downwards, and are crossed from time to time by tabulæ or partitions, which are few in number and wide apart.

All these details point very decidedly to the nature of the organism with which we have to deal. It is a *Millepore*, but of an exceptional and peculiar type. Until very lately these singular corals were ranged amidst the *Madreporaria tabulata*. Their true character was, however, discovered by Agassiz on one of his cruises to the reefs of Florida. Prof. Dana says that he often had Millepore corals under study in the Pacific, and waited long for the expansion of the animals, but was never gratified by their making

their appearance.* Agassiz observes that they are very slow in expanding themselves. When expanded they have no resemblance to true polyps. There is simply a fleshy tube with a mouth at top and a few small rounded prominences in place of tentacles, four of them sometimes largest. The corals of the *Milleporæ* are solid and strong, as much so as any in coral seas. They have generally a smooth surface, and are always without any prominent calices, there being only very minute rounded punctures over the surface from which the animals show themselves. The cells in the coralline are divided parallel to the surface by very thin plates or tables. The *Milleporæ* are very abundant corals. They extend outside the tropics in Australia as far south as Moreton Bay. In the West Indies they contribute largely to the formation of the reefs.

According to Professor Verrill, there are thirteen species of the genus *Milleporæ* known, but two of these, *M. moniliformis* and *complanata*, are supposed to be varieties of *M. alcicornis* and *plicata* respectively. Without any exception they are all tropical and living. They occur, as already stated, in the West Indies, and also in the Indian Archipelago, the Red Sea, Mauritius, and the Fiji Islands. The occurrence, therefore, of a species in New Zealand, and in so cold a latitude as Foveaux Strait, is most singular and interesting. Such facts have a tendency to make us doubt some of the geological conclusions at which we sometimes arrive. A few years ago, the discovery of two reef-building genera of corals in the tertiary beds of Tasmania was looked upon as the evidence of an almost tropical climate. Indeed, a discussion ensued at the Geological Society of London as to whether it might not be presumed that the axis of the earth had shifted since these beds were deposited. The coral to which I am now drawing attention is truly of a reef-building kind, but I am not aware whether it forms reefs. This would be a very interesting subject of enquiry. I have named the species *Millepora undulosa*, from the peculiar undulating character of the surface of the branches. It is thus described :—

Millepora undulosa, n.s.

Corallum arborescent, very much branched, branches crowded cylindrical, spreading in all directions, generally somewhat flattened at the extremity and with a short bifurcation, often coalescent, either along the whole side of the branch or just at a point of contact, or by sending out a short small branchlet from one stem to another. The whole surface of the branches undulating with broad but not deep rugosities; cells exceedingly small, crowded, giving a spongy appearance; colour, dull reddish-brown. Altitude of specimen described 80; width at farthest extremity of branches

* Corals and Coral Islands, by James D. Dana, English Edition, p. 79.

52; diameter of branches from $3\frac{1}{2}$ to 6; diameter of extremity of branch at bifurcation, 7 millimetres.

It is nearest in shape, dimensions, etc., to *M. tortuosa*, of Fiji, the only known Pacific form.

Note.—*Millepora undulosa* is obtained not uncommonly by the Stewart Island oyster dredgers, in from 14 to 20 fathoms of water, along with *Cinctipora elegans*, *Pustulipora purpurascens*, *Idmonea radians*, and other polyzoa. I am not aware that it forms anything like reefs.—F. W. H.

Art. XLI.—*Notes on the Life History of* Charagia virescens. By the Rev. C. H. Gosset. Communicated by Prof. Hutton.

[*Read before the Otago Institute, 8th October,* 1878.]

The larva lives chiefly on the extremely hard wood of the Black Maire (*Olea apetala*), but I have also found it in a tree known to the settlers about Masterton as the wine-berry or New Zealand currant tree (*Aristotelia racemosa*). The wood of this last differs widely from the Maire, being very soft and white. I believe I have once or twice found the larva in other trees. *C. virescens* passes certainly three years in the larval state, probably four. In this stage of its existence it is extremely plentiful wherever the Black Maire abounds. It is not easy to find a single tree of this species that is not more or less honeycombed by its ravages; the imago, however, is far more rare. Of the larva I have obtained twenty specimens in about an hour, notwithstanding the loss of time in getting them out, whereas I have only come across seven specimens of the perfect insect in four seasons. I believe I have once seen it on the wing, but I am not positive about it. I have generally come across it half dead, partially stiff and much faded and frayed. I have also found the wings, the insect having evidently fallen a prey to some bird.

When newly emerged the perfect insect is very beautifully marked with blackish markings, but these soon fade, or get rubbed off, and the insect then presents a pretty uniform green with a few whitish markings.

Although the larva is so plentiful, it requires a little practice to detect its burrow readily. If the limbs or trunk of a Black Maire be carefully examined, a more or less diamond-shaped mark, two or three inches in the side, may often be noticed, which varies slightly in tint from the surrounding bark; and if this patch is pressed with the finger it gives way; if the patch is torn off it is seen to be composed of yellowish or greyish silk, covered on the outside with scraps of bark, lichens, excreta of the larva, etc., the whole

forming a wonderfully close imitation of the natural bark of the tree. Beneath this covering is seen a cavity, the depth of which varies from a quarter to half an inch, and rather above the centre of the cavity is the entrance to the burrow. The cavity around the entrance of the burrow is used by the larva to turn itself in. The burrow at first takes a course inwards and upwards for one, two, or more inches; this upward inclination preventing the entrance of water. Then the burrow turns downward in a nearly vertical direction. This vertical portion of the burrow varies in length according to the age of the larva. That of a full-grown larva is about four or five inches long. I have seen them eight inches and proportionally wide. I have ascertained positively that the larva frequently inhabits the same burrow for more than two years, and I am of opinion that they generally keep to the same burrow during the whole larval stage. But I have occasionally found larvæ in terminal shoots which would not admit of their attaining full growth, and consequently they must in these cases change their ground.

When the larva has attained its full size, it spins, at the top of the vertical portion of its burrow, a contrivance very much resembling that of the Trap-door Spider, as an additional security against its foes during the pupa state.

The imago emerges in October and November. The best time to obtain the pupa is in September and the early part of October. It is easy to ascertain if the insect in a burrow is in the larval or pupa stage, for, if the exterior web is torn off, the larva, if inside, will replace it by the next day.

The larva is flesh-coloured, tinted with purple; head dark brown, with a few strong bristles; spiracles black; segment next the head darker than the rest, horny, with a large black mark on each side, just above the spiracle.

The pupa is flesh-coloured, inclining to brick red; head and thorax deep chestnut brown. The semi-transparent wing-cases show the markings of the future imago.

I have examined these larvæ and pupæ in their different stages up to the time when by stripping off the pupa case, just before the insect was ready to emerge, the easily recognised *Charagia virescens* was disclosed.

I do not think that the larva of *C. virescens* is the larva which is attacked by the fungus *Cordiceps robertsii*. Not only do the two larvæ differ in the size of the head and shape of the body—the larva of *C. virescens* being more cylindrical and with proportionately a larger head—but I do not see how *C. virescens* could get into the ground, which is the position in which the larva, which is attacked by the fungus, always is found. I think that the fungus-attacked larva is probably a *Porina*.

ART. XLII.—*Further Notes on the Habits of the Tuatara Lizard.*
By WALTER L. BULLER, C.M.G., Sc.D., F.L.S.

[*Read before the Wellington Philosophical Society, 3rd August, 1878.*]

IN Vol. IX. of the Transactions I gave an account of a number of tuatara lizards (*Sphenodon punctatum*) which I had received from the Island of Karewa, in the Bay of Plenty, in April, 1876, to which were afterwards added an adult pair of my *Sphenodon guntheri* and a young one of the same species, obtained by exchange from the Colonial Museum. It is now nearly two years since I received these lizards, and I have a few notes to add to the observations so fully recorded in that paper.

For many months my captive lizards ate nothing, although I tempted them with all sorts of savoury morsels. A small tree lizard (*Naultinus*) which I placed in the cage with them disappeared; but whether it was devoured by the tuataras or effected its escape I was unable to determine. They were sluggish in their movements, and usually appeared to be asleep with their eyes partially closed, even when lying in the trough of water with their bodies submerged. As the summer approached they showed more activity and began to feed, evincing a decided preference for flies and the large brown locust (*Cicada*), of which latter they sometimes devoured as many as fifty in the course of a day. But as it was necessary to catch the locusts on the garden trees before they could be supplied, for many days together the tuataras were compelled to fast, as they stubbornly rejected the minced meat which we continued to place in the cage. As winter came round again they relapsed into their former languid state, although never absolutely torpid, and for two or three months did not eat a morsel of any thing. In November last we tried them with earth-worms, of which they partook freely. When the supply of worms ran out we gave them fresh meat again. *Sphenodon punctatum* refused it, but (strange to say) *Sphenodon guntheri* devoured it greedily, gorging themselves to repletion. Apparently from this cause (following so immediately on the prolonged fast) the largest of them died. About this time also they developed a new phase of character by attacking and biting one another. One lost an eye, and another had a portion of his under lip torn off, completely altering the expression of his face. The half-grown *Sphenodon guntheri* suffered most. First of all he had the end of his tail bitten off, and ultimately he was killed outright, the whole of his tail consumed, and one of his hind legs much crunched and lacerated.

A temporary change of residence made it difficult for a time to obtain locusts, and the lizards (with the exception of the surviving *L. guntheri*)

refusing the ordinary fare of fresh meat, from December to February they were on very short commons indeed, and practically ate nothing. In March a new feature of character came to light, and one likely to affect most favourably their future prison life. My son, Percy, having brought home one day a basket-full of sea-minnows, for the purpose of feeding a tame skua, out of mere curiosity I offered one of them to the tuataras; it was instantly pounced upon by the nearest of them, and a few minutes afterwards each of the lizards was crunching and swallowing a fish three or four inches long with evident relish. Some more were placed in the cage and were eagerly devoured. Seeing how very difficult it is to induce the tuataras to take other than their natural food, it is sufficiently manifest that fish-eating is nothing new to them. Their evident fondness for water, basking as they do in the tin reservoir for the most part of the day and often with the head submerged, raises the question whether they are not, in point of fact, amphibious animals, subsisting in their wild state, to some extent at least, on fish and other marine life. I have experimented by filling their trough with sea water, and they have taken to it just as readily as when the bath was of fresh water. I have not yet had an opportunity of trying them with a larger vessel, containing live fish. But feeding our tuataras plentifully with small fish in the manner described, we have succeeded in advancing their education another step, for they will now partake freely of fresh meat, in almost any quantity, if minced up and offered at the end of a fork or pointed stick. It is amusing to watch this operation. The lizards climb up the inclined floor of the cage, and then clinging to a projecting stone they elevate the head and watch in a stupid way till the food is offered, when they deliberately snatch it away, and then proceed very slowly to crunch it between their jaws before swallowing. While thus feeding they remind one of a tame bear at the top of his pole. When a live fly or locust is thrown into the cage, the tuatara approaches it in the same cautious way, then turns his head so as to bring his vision in a line with the object, which he eyes intently for a moment, and then seizes with a rapid movement, the tongue being protruded.

Having kept and closely watched both species of tuatara, I am satisfied that they not only differ in their superficial characters but also in habits and disposition. The Museum examples, all of which, except the two received from me, belong to *Sphenodon guntheri*, feed readily on fresh meat, soaked bread, and indeed almost anything edible that is offered to them, and they have done so from the first. Till very recently all my specimens of *S. punctatum* obstinately refused the fresh meat, were always more lethargic than the other form, and when roused appeared to be more shy and timid. Both species are equally fond of basking in the water.

Note on the Tuatara from East Cape Island.

In a paper* read before this Society last year, I described a new form of tuatara (*Sphenodon guntheri*, var.), from East Cape Island, in the possession of Mr. John White, of Napier. Referring to this specimen, Mr. White writes me :—" The tuatara which my son Arthur has, was obtained in the year 1873 from the island called Whangaokino at the East Cape. The native who got it informs me that he saw on this island tuataras green in colour, and others like the one in question."

Art. XLIII.—*On the specific Value of* Prion banksii. By W. L. Buller, C.M.G., Sc.D.

[*Read before the Wellington Philosophical Society, 3rd August*, 1878.]

In treating of *Prion banksii*, in my " Birds of New Zealand " (page 311), I made the following observations :—" The propriety of retaining the above specific distinction appears to me very doubtful ; but I am unwilling to dismiss the supposed species till the subject has been further investigated." In an article which I afterwards contributed to our Transactions,† I expressed my belief that the species would stand, and pointed out what appeared to me good distinguishing characters.

A recent visit to the West Coast, after very stormy weather, has enabled me to settle this point beyond all doubt. A north-west gale had been blowing for several days, and large numbers of *Prion* had been washed ashore. In travelling by coach from Waikanae to Otaki, a distance of only ten miles, I counted no less than twenty-seven lying on the strand, and there were probably many more. As I performed the rest of the journey to Manawatu in a buggy, I was able to stop and pick up specimens. In this way I was fortunate enough to obtain, during one day, twenty fresh birds. Of these, twelve were referable without hesitation to *Prion turtur* and eight to *Prion banksii*. The difference in the size and form of the beak was constant, and among individuals of each species there was only a slight variation. I selected the smallest of *Prion banksii* for the purposes of comparison, and I beg now to exhibit it together with an ordinary specimen of *Prion turtur*. It will be seen that the two birds are very readily distinguishable.

Thinking that the difference in the size of the bill might possibly be a

* Transactions New Zealand Institute, Vol. X., p. 220. † Vol. VII, p. 208.

sexual character, I dissected the whole of the twenty specimens, with the following result:—Of *P. banksii* there were four males and four females; of *P. turtur* there were seven males and five females. In some cases, owing to the state of the productive organs at this season of the year (first week in July), I was unable to determine the sex with absolute certainty. In others, however, the testes were sufficiently conspicuous; while in two females of *P. turtur* and in one of *P. banksii* I was able to detect a bunch of undeveloped eggs. The examination in this respect was therefore conclusive, and I have now no hesitation in admitting *P. banksii* into the list of well established species. *Diagnosis*:—Similis *P. turturi*, sed rostro latiore, pileo saturatiore et caudâ nigro latiús terminatâ distinguendus.

All the specimens picked up by me on this occasion were dead, with the exception of the *Prion banksii*, now exhibited. I found this one on the sandy beach, where the surf had left him, sitting up in wet and draggled plumage, looking the very picture of abject misery. Beside him stood a seagull *(Larus dominicanus)* patiently waiting for his victim to succumb before commencing his savoury feast, when the unbidden guest appeared in the guise of a naturalist!

Dr. Finsch refers the *Prion vittatus*, and *P. banksii* of Hutton's "Catalogue," to *P. banksii*, Smith, and *P. turtur*, Sol., respectively, and he is certainly right in doing so; for Prof. Hutton gives his *P. banksii* a bill only the decimal part of an inch broader than that of *P. turtur*, while he makes that of *P. vittatus* only ·6. On reference to the figures accompanying my paper in Vol. VII., it will be seen that the width of the bill in the true *P. banksii* is ·55, and in *P. vittatus* ·85.

Dr. Finsch agrees with me in sinking Gould's *Prion ariel*, as it cannot be separated from *P. turtur;* and he unhesitatingly refers the bird described by Mr. Potts under the name of *Prion australis* to *P. vittatus*, Dr. Hector having forwarded him a specimen for examination. Not having seen the type of *P. australis*, I accept Dr. Finsch's determination; but it must be borne in mind that Mr. Gould, who was quite familiar with *P. vittatus*, declares positively that there is another and broader-billed species, adding, however, "the precise latitudes in which this fine bird flies are unknown to me."

ART. XLIV.—*Remarks on the Long-tailed Cuckoo* (Eudynamis taitensis).
By WALTER L. BULLER, C.M.G., Sc.D.

[*Read before the Wellington Philosophical Society, 3rd August,* 1878.]

THERE is a remarkable phenomenon in the animal world known to naturalists as "mimicry," or the law of protective resemblance. It is developed chiefly among insects, and particularly among the *Lepidoptera*. Mr. Wallace describes, at page 205 of his enchanting book on the "Malay Archipelago," a butterfly which, when at rest, so closely resembles a dead leaf as almost to defy detection. The varied details of colouring combine to produce a disguise that so exactly represents a slightly curved or shrivelled leaf as to render the butterfly quite safe from the attacks of insectivorous birds, except when on the wing. The flight of the species, on the other hand, is so vigorous and rapid that it is well able then to protect itself. Mr. Wallace adds that in many specimens there occur patches and spots, formed of small black dots, so closely resembling the way in which minute fungi grow on leaves, that it is impossible not to believe that fungi have grown on the butterflies themselves! This protective imitation must obviously favour the species in the common struggle for existence, and may of itself be sufficient to save it from extinction. But there is another kind of "mimicry" where one insect which would, on discovery, be eagerly devoured, assumes for similar protective purposes a close resemblance to some other insect notoriously distasteful to birds and reptiles, and often belonging to a totally different family or order. Numberless instances might be given in illustration of this singular fact, every department furnishing examples of adaptation more or less complete, and all being explainable on the principle of variation under natural selection or the "survival of the fittest." Mr. Wallace, when exploring in the Moluccas, was the first to discover similar instances of mimicry among birds, although the law of protective colouring had long been observed to exist in the case of birds' eggs. He gives two very curious examples of external resemblance, co-existing with very important structural differences, rendering it impossible to place the model and the copy near each other in any natural arrangement. In one of these a honey-sucker has its colours mimicked by a species of oriole, and the reason is thus stated:—"They must derive some advantage from the imitation, and as they are certainly weak birds, with small feet and claws, they may require it. Now, the Tropidorhynchi are very strong and active birds, having powerful grasping claws, and long, curved, sharp beaks. They assemble together in groups and small flocks, and they have a very loud, bawling note, which can be heard at a great distance, and serves to collect

a number together in time of danger. They are very plentiful and very pugnacious, frequently driving away crows and even hawks, which perch on a tree where a few of them are assembled. It is very probable, therefore, that the smaller birds of prey have learnt to respect these birds, and leave them alone, and it may thus be a great advantage for the weaker and less courageous Mimetas to be mistaken for them. This being the case, the laws of Variation and Survival of the fittest, will suffice to explain how the resemblance has been brought about, without supposing any voluntary action on the part of the birds themselves; and those who have read Mr. Darwin's 'Origin of Species' will have no difficulty in comprehending the whole process."

Among the many minor instances that have attracted notice, the English cuckoo (*Cucubus canorus*) is supposed to derive protection from the resemblance of its markings to those of the sparrow-hawk (*Accipiter nisus*), but the resemblance is far more striking between our long-tailed cuckoo (*Eudynamis taitensis*) and a North American species of hawk (*Accipiter cooperi*). In the fine specimens of the former which I exhibit this evening, it will be observed that the markings of the plumage are very pronounced, while the peculiar form of the bird itself distinguishes it very readily from all other New Zealand species. Beyond the general grouping of the colours there is nothing to remind us of our own bush-hawk, and that there is no great protective resemblance is sufficiently manifest from the fact that our cuckoo is persecuted on every possible occasion by the tui, which is timorous enough in the presence of a hawk. During a trip, however, on the Continent, in the autumn of 1871, I found in the Zoological Museum at Frankfort, what appeared to be the accipitrine model, in a very striking likeness to our bird. Not only has our cuckoo the general contour of Cooper's sparrow-hawk, but the tear-shaped markings on the under parts and the arrow-head bars on the femoral plumes are exactly similar in both. The resemblance is carried still further in the beautifully banded tail and marginal wing-coverts, and likewise in the distribution of colours and markings on the sides of the neck. On turning to Mr. Sharpe's description of the "young male" of this species in his Catalogue of the Accipitres in the British Museum (p. 137), it will be seen how many of the terms employed apply equally to our *Eudynamis*, even to the general words "deep brown above with a chocolate gloss, all the feathers of the upper surface broadly edged with rufous."

The coincident existence of such a remarkable resemblance to a New World form, cannot of course be any protection to an inhabitant of New Zealand, and I do not pretend in this instance to apply the rule; but in the light of natural selection, to which at present no limit can be assigned, the fact itself is a suggestive one, the more so when we remember that this

cuckoo of ours is not a permanent resident, but migrates every winter to the Society Islands. Of this annual migration, across 1,500 miles of ocean, Captain Hutton has well remarked "there is nothing in the whole world so wonderful!"

ART. XLV.—*Remarks on a Species of* Lestris, *inhabiting our Seas.* By WALTER L. BULLER, C.M.G., Sc.D., etc.

[*Read before the Wellington Philosophical Society, 17th August,* 1878.]

I HAVE the pleasure of exhibiting this evening, in illustration of the remarks I am about to offer, the only four known examples of the small Skua yet obtained in New Zealand. The first of these is the adult bird described in my "Birds of New Zealand" (p. 268), and shot by myself at Horowhenua, on April 30th, 1864; the second is Dr. Hector's young specimen, noticed by me in the Transactions, Vol. VII., p. 225; the third is another young bird, shot in Wellington Harbour in January, 1877, and mentioned in my paper in last volume of Transactions, p. 200; and the fourth, and most recent, is a specimen in more mature plumage, for which I am indebted to Mr. C. H. Robson, who picked it up at the beach at Cape Campbell, in a perfectly fresh state, in the last week of November, 1877.

In my work I referred the first-named example to *Stercorarius parasiticus*, Linn., and added the following remarks:—"Dr. Finsch, to whom I submitted the skin, is of opinion that it is an immature bird; and Mr. Howard Saunders, who has made the *Laridæ* his special study, expresses his conviction that it is a new and hitherto undescribed species. I am rather disposed, however, to consider it an aged female of the species known as Buffon's Skua, with the plumage much faded and worn, indicating a sick or exhausted condition of body. I may add that the two middle tail-feathers are only partially developed, being encased in a sheath at the base. They extend only about an inch beyond the rest, and are much abraded, having a peculiar filamentous appearance."

Mr. Howard Saunders, who, as Lord Walden justly says, may be considered the "first authority" on the family of birds to which the Skua belongs, communicated to the Zoological Society on the 3rd March, 1876, a paper "On the *Stercorariinæ* or Skua Gulls," in which he deals chiefly with the synonymy and geographical range of the members of that group.

In his list of synonyms of *Stercorarius crepidatus* (Richardson's Skua) Mr. Saunders includes my *Stercorarius parasiticus*, and in his account of the species he observes that he can refer to no other the example recorded, as above-mentioned, in my book, adding—"His general description suits *S.*

crepidatus; and he expressly states that the shafts of the primaries are *white*, the characteristic which particularly serves to distinguish it from Buffon's Skua, with which he has identified it. At the time that I examined the specimen in question, I was not aware of this distinctive feature; the skin, also, had been badly preserved; and, to make matters worse, the plumage was so worn and abraded that it is a marvel that the bird was able to fly at all."

Mr. Saunders has evidently, in this case, trusted more to his memory than to the notes which, we may assume, he would make on examining a novel specimen—one which, in fact, he took to be a "a new and hitherto undescribed species." It will be seen, at a glance, that the specimen now before the meeting (which passed through Mr. Saunders' hands in the same condition) instead of being a "badly prepared skin" is a first-class cabinet specimen, and that, instead of having "the plumage so worn and abraded as to make it a marvel that the bird could fly at all," the wings are in perfect plumage, the only abraded feathers being about the head and neck, which could not well affect the flying capabilities of the bird.

It would almost seem that Mr. Saunders has not the courage of his opinion, although, as it turns out, his first expressed conviction on seeing my specimen is not unlikely to prove the true one after all.

Of *Stercorarius crepidatus* Mr. Saunders says:—"Dr. Coues follows those authors who have chosen to divert Linnæus's name of *L. parasiticus* to this species—a supposition utterly negatived by the description in the Syst. Nat., p. 226, which is based upon that in his 'Fauna Suecica,' p. 55, No. 156. Nothing could well be clearer than this statement:—'Rectricibus duabus intermediis *longissimis*,' which can only apply to Buffon's or the Long-tailed Skua; but, as if to make assurance doubly sure, Linnæus adds 'remiges nigræ, *rachi* 1. 2. *nivea*.' The natural inference, from drawing especial attention to the fact that the *shafts* of the *first* and *second* primaries are *white*, is clearly that those of the other primaries are *not* white. Now the particular characteristic by which Richardson's Skua may be distinguished, at any age beyond that of the nestling, is that the shafts of the other primaries are conspicuously lighter than in those of Buffon's Skua, in which *only* those of the first and second primaries are white, those of the third and successive primaries being dark. I am indebted to Mr. R. Collett, of Christiania, for pointing out to me, some years since, this excellent distinction. The *Lestris parasiticus* of Linnæus is therefore not *S. crepidatus*, but the Buffon's Skua; and so is, according to my view, *Catharacta parasiticus* of Brünnich, but it is needless to discuss the latter name as it is out of date."

If Mr. Saunders is right in making this character of the shafts a specific

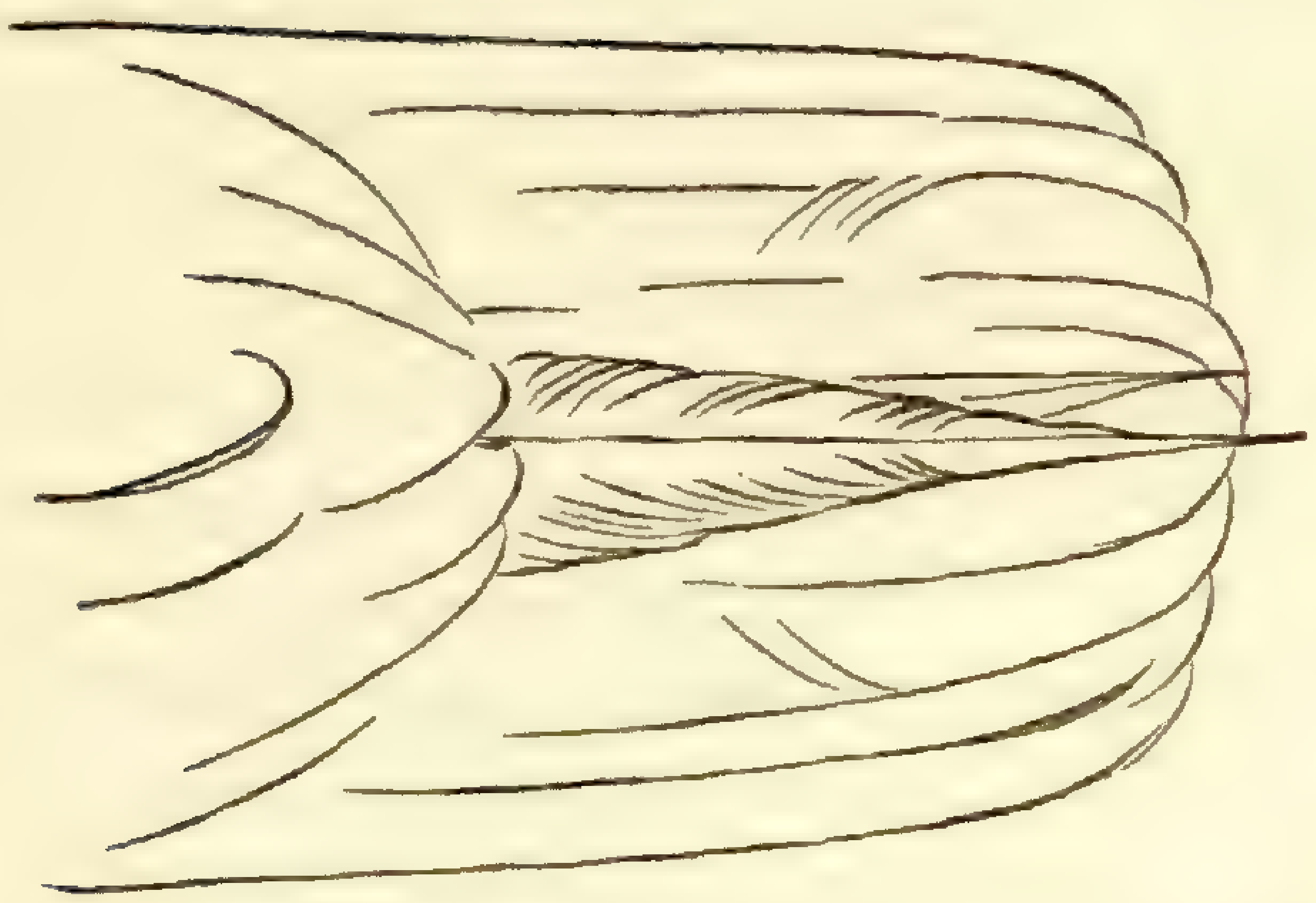
test, it is sufficiently evident that our bird is not *Stercorarius parasiticus*, as Dr. Finsch and myself had supposed; for it will be seen that in all the specimens now exhibited the whole of the primaries have white shafts.

The next point to be considered is whether Mr. Saunders is right in referring it to *Stercorarius crepidatus.* He says:—"Dr. Coues considers that the *Larus crepidatus* of Gmelin is in all probability based upon the young of the Pomatorhine Skua, to which Brisson gave the name of *Stercorarius striatus.* It is true that Gmelin (who translated from Latham) identifies *S. striatus* of Brisson with his *L. crepidatus*; but although *S. striatus* is certainly a young Pomatorhine, it was by no means easily recognizable by the naturalists of that day. * * * On referring to Hawkesworth's Voyages (1773) Vol. II., p. 15 (not Vol. I., p. 15, as erroneously cited by Latham, and of course duly copied by Gmelin, without reference), we find in the narrative of Lieut. Cook's Voyage in the 'Endeavour' that "on the 8th Oct., 1768, when a little to the South of the Cape-Verd Islands, Sir Joseph Banks shot the black-toed gull, not yet described according to Linnæus's system; he gave it the name of *Larus crepidatus*. The black-toed gull is described in Pennant's British Zoology Vol. II., p. 419 (1768); and plate 2 is an excellent representation of Richardson's Skua of the year, *the feet of this species at that age having the upper parts of the webs yellowish, and the posterior portion black*, giving the bird the appearance of being 'shod' or 'sandalled,' whence Bank's somewhat quaint Latin rendering." (The italics are mine).

If this character of the coloured feet is reliable, then it is pretty evident also that our bird is not *Stercorarius crepidatus*; for it will be seen that in the young examples exhibited, the feet are similar to those of the adult—a uniform greyish-black—if we except a dull spot of yellow at the inner angle of the toes. There is nothing of the 'sandalled' appearance described by Sir Joseph Banks, though possibly a still younger bird might exhibit more of the yellow.

I do not care to pronounce any distinct opinion till I have received specimens of the European bird for comparison with ours; but it seems to me that the nearly adult example of the New Zealand bird, now exhibited, is readily separable from the adult of *S. crepidatus* as described in the books of reference. The "burnished acuminate feathers" on the nape are wanting in our bird, and the points of the two narrow, overlapping tail-feathers extend only two decimal parts of an inch beyond the rest, as shown in the accompanying sketch (fig. 1):—

1



Reduced to half the natural size.

On a comparison of these specimens it is perfectly clear that the one originally described by me in the 'Birds of New Zealand' is an adult bird, and not "immature" as Dr. Finsch supposed. It is in the condition of those described by Mr. Saunders from Layard's collection, "all of which were in the act of losing and renewing the central tail-feathers and the outer primaries, which are the last to be moulted." The remarkable filamentous appearance of the central rectrices in my first bird is shown in the second sketch (fig. 2) :—

2

Reduced to half the natural size.

There is an obvious difference in the colouration of the two quasi-adult specimens exhibited, the one having (as described in my work) the breast greyish-white and the abdomen ashy-grey, tinged with brown, while the other has the entire under surface white, marked on the breast and sides with interrupted bars of sooty brown. In both, however, the under surface of the wings and the axillary plumes are of a uniform dark ashy-grey. These individual differences are thus accounted for by Mr. Saunders in treating of *S. crepidatus* :—"It is now well known that there are two very distinct plumages to be found in birds of this species, even in the same breeding-places—an entirely sooty form, and one with light underparts—and that white-breasted pair with whole-coloured birds as well as with those of their respective varieties. If this species is 'dimorphic,' the offspring of one parti-coloured and one white-coloured bird ought to resemble one or other of their parents without reference to sex. My examination of upwards of a hundred specimens from widely different localities, and in all stages, inclines me to the belief that this is not the case, and that the young of such union will be intermediate, whilst the offspring of two similar parents will 'breed true.' This point can only be solved by

some ornithologist, who will devote his attention to a colony during the breeding-season, observing the produce of all these unions, and, if possible, marking the nestlings before they take wing. It is worthy of notice that in Spitzbergen, its most northern breeding-ground, neither Dr. Malmgren nor Professor Newton found a single example of the dark whole-coloured form; all those which Admiral Collinson's and Dr. Rae's expeditions brought home from the far North are also white-breasted specimens, which looks as if the dark form was a more exclusively Southern one."

Art.—XLVI.—*Note on Mr. Howard Saunders' Review of the* Larinæ, *or Gulls.* By Dr. Buller, C.M.G.

[*Read before the Wellington Philosophical Society, 11th January*, 1879.]

Mr. Howard Saunders, in his revision of the *Larinæ*, in the Proc. Zool. Society, Part I., 1878, steps out of his way (at page 161) to notice my having adopted Bonaparte's *Bruchigavia*, "a genus playfully made," for a New Zealand species, this being as he states "its only claim to remembrance." Had Mr. Saunders possessed that close acquaintance with the literature of his subject which is supposed to be an essential qualification in a monographist, he would of course have been aware that Mr. Gould, in his "Handbook to the Birds of Australia" (published in 1865), adopted Bonaparte's playful name for "a genus of gulls the members of which are delicate in their structure, elegant in their appearance, and graceful in all their actions"—deliberately substituting that generic title for *Xema*, the one previously used in his folio edition.

In 1869, in a communication to 'The Ibis,' I described a new species of this group from New Zealand, and provisionally referred it to that genus under the name of *Bruchigaria melanorhyncha*. To this, no doubt, Mr. Saunders' attempted witticism refers, although (at page 190) he incorrectly quotes me for "*Bruchigavia melanorhynchus.*" But when I treated of the group more exhaustively in my 'Birds of New Zealand' (1872), as Mr. Saunders is or surely ought to be aware, I adopted the generic division of *Larus* for this (= *L. bulleri*) and the allied forms.

Mr. Saunders is entitled to our thanks, however, for having apparently cleared up the confusion in the nomenclature of this species with *Larus pomare*. He states that during a recent visit to Bremen he went into the whole question with Dr. Finsch, who had previously studied the subject, and had made numerous and careful drawings of the primaries of Bruch's types of *L. pomare* in the Mainz Museum, and of many other specimens. He gives figures of the three outer primaries of *Larus bulleri*, and says, "I have examined the type of Bruch's *L. pomare* of 1855, and it is undoubtedly of this species; but the type of his *L. pomarre* of 1853 is as certainly *L. novæ-*

hollandiæ." When I was in London, Dr. Finsch courteously forwarded me the same drawings for examination, but, as stated at page 277 of 'The Birds of New Zealand,' I was unable to accept his conclusions, my bird being entirely distinct from the so-called type which I had seen in the Mainz Museum. The explanation now offered puts the matter in a perfectly clear light; and both *pomare* (Bruch) and *melanorhyncha* (mihi) having been previously employed for other species, our black-billed gull must stand as *Larus bulleri*, Hutton, under which name it is described and figured in my work.

Art. XLVII.—*On a further Occurrence of the Australian Tree Swallow* (Hylochelidon nigricans) *in New Zealand.* By Walter L. Buller, C.M.G., D.Sc.

[*Read before the Wellington Philosophical Society, 17th August*, 1878.]

In the 'Birds of New Zealand' I have recorded two distinct occurrences of the Tree Swallow in this country as a visitant from Australia. In the summer of 1851, Mr. F. Jollie observed a flight of swallows at Wakapuaka, in the vicinity of Nelson, and succeeded in shooting one; and on the 14th March, 1856, a specimen was shot by Mr. Lea, at Taupata, near Cape Farewell. This is still preserved in the Otago Museum. It would appear from some observations made by the late Sir David Monro, at a meeting of this Society in February, 1875,* that there have been other instances of its occurrence in Nelson. Having reference, no doubt, to the same bird, I have lately received the following interesting communication from a gentleman in Blenheim:—

"22nd June, 1878.

"Dr. W. L. Buller, Wellington.

"Dear Sir—Knowing the great interest you take in the ornithology of New Zealand, I wish to bring under your notice the following:—

"On Sunday, the 9th instant, about two miles from Blenheim, on the bank of the Opawa River, I saw the first martin I have met with in New Zealand. The bird was hawking after insects close to the ground in a ploughed field. I was accompanied by two residents in Blenheim at the time, and we watched it closely for some time. It passed us at one time within a few yards. There was no mistaking either the appearance or the flight of the bird. It seemed to me more like the English house martin than the common Australian martin. It seemed, however, dingier in the black than the English bird, and rather smaller—more like the sand-martin, indeed.

"Unfortunately I was absent from the district for some days after seeing it, but since returning I have carefully watched for its re-appearance. I have not again seen the bird, so presume it has shifted its quarters.

"I shall be glad to hear from you if you have had any notice sent you of the appearance of the martin in New Zealand.—I am, dear Sir, yours truly,

"J. R. W. Cook."

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* Trans. N.Z. Inst., Vol. VII., p. 510.

Art. XLVIII.—*Additions to List of Species, and Notices of Rare Occurrences, since the publication of 'The Birds of New Zealand.'* By Walter L. Buller, C.M.G., Sc.D.

[*Read before the Wellington Philosophical Society, 3rd August*, 1878.]

Platycercus alpinus, *Buller*, Ibis, 1869, p. 39.

Sp. nov. *P. auricipiti* similis, sed minor et fronte aurantiacâ, vertice pallide flavo distinguendus.

This species, originally described from a specimen forwarded to me by Dr. von Haast, was for a time reduced to the rank of a synonym; but its validity, as a species distinct from *Platycercus auriceps,* was established, beyond all doubt, just in time to allow of my noticing it in the supplementary notes to the 'Birds of New Zealand.' (See Introduction, page XVI.)

Platycercus rowleyi, *Buller*, Trans. N.Z. Inst., Vol. VII., p. 219

Sp. nov. *P. novæ-zealandiæ* similis sed conspicuè minor.

This species, although exactly similar in plumage to *Platycercus novæ zealandiæ*, is so much smaller in size as to be less than some examples of the yellow-fronted parrakeet *(P. auriceps)*. There can be little doubt about its being a distinct species, although I am not sure that my name will stand against Mr. G. R. Gray's *Platycercus aucklandicus.* I may mention, however, that it is smaller than the type of the last-named species in the British Museum.

Rhipidura fuliginosa, *Sparrm.*, Mus. Carls., p. 47.

Several more instances of the occurrence of this southern species in the North Island have been recorded. (See Trans. N.Z. Inst., Vol. IX., p. 330; *Ib.*, Vol. X., p. 194.)

? Gerygone sylvestris, *Potts*, Trans. N.Z. Inst., Vol. V., p. 177.

Dr. Finsch seems to be in favour of admitting this species; at any rate, pending further information. I have never had an opportunity of seeing the type, but I shall be glad if my supposition of its being the same as *Gerygone albofrontata* should prove erroneous.

Aplonis zealandicus, *Gray*, App. Dieff., N.Z. II., p. 191.

This species, described as *Lamprotornis zealandicus*, by MM. Quoy and Gaimard, in the "Voyage of the Astrolabe," was expunged from the list of New Zealand birds as of doubtful authenticity; but Dr. Otto Finsch has set the matter beyond question by an examination of the type specimens at Paris and Leiden, which were obtained at Tasman's Bay. (See Trans. N.Z. Inst., Vol. VIII., p. 198.)

Rallus brachipus, *Swains.*, An. in Menag., p. 336.

Lewinia brachypus, Bonap. Compt. Rend. de l'Acad. Sci., tom. XLIII. Séances des 15 et 22 Sept., 1856.

Rallus lewinii, Gould, Birds of Australia, fol. VI., pl. 77.

Baron A. von Hügel, in a communication to 'The Ibis' (July 1875), writing from Christchurch, says:—"I have received a rail killed on the Auckland Islands by the unfortunate Captain Musgrave of the 'Grafton.' As soon as I got the bird I was struck with its resemblance to one of the *Rallidæ* I was acquainted with, but for some time could not make out which. At last it struck me that it must be the Australian *Rallus brachypus*, and on comparing the Auckland with the Australian bird, I found them to agree very closely, though the colouring seemed different, but as the Canterbury Museum specimen appears to be very old and faded, it is impossible to judge. I shall be able to determine if my rail is *Rallus brachypus*, or new, as soon as I get to Melbourne, there being a good series there. At all events it is the first rail known to have been procured in the group."

? Ocydromus brachypterus, *Lafr.*, Mag. de Zool., 1842, pl. 42.

As already explained in my paper on the genus *Ocydromus*,* the above is the fourth New Zealand species, if another is really admissible.

Cabalus modestus, *Hutton*, Ibis, July, 1872.

Several specimens of this now well-established form have been received from the Chatham Islands.

Numenius cyanopus, *Vieill.*, 2nd Edit. du Nouv. Dict. d'Hist. Nat., tom. VIII., p. 306.

The occurrence of this species in New Zealand was first mentioned by myself, on the authority of Dr. Hector, in the Transactions of the New Zealand Institute, Vol. VII., p. 224; and in the following year, Dr. von Haast described two male specimens, obtained in Canterbury (Trans. N.Z. Inst., Vol. IX., pp. 427-429).

Numenius uropygialis, *Gould*, Proc. Zool. Soc., part VIII., p. 175.

Specimen shot at the Wairau and presented to the Colonial Museum by Mr. Travers. Noticed in my communication to the Wellington Philosophical Society on 10th February, 1875.†

Himantopus albicollis, *Buller*, Trans. N.Z. Inst., Vol. VII., p. 224.

Sp. nov. Capite toto cum collo undique et corpore subtus toto albis; inter-scapulio, scapularibus cum dorso summo et tectricibus alarum nigris; remiges angustè albido terminatis; subalaribus nigris; dorso postico et uropygio albis; caudâ nigrâ: rostro nigro: pedibus pallidè cruentatis.

* Trans. N.Z. Inst., Vol. X., pp. 213-216.

† Trans. N.Z. Inst., Vol. VII., p. 224.

Limnocinclus acuminatus, *Horsf.;* Jard. and Selb. I.O., pl. 91.

Several specimens in Canterbury Museum.

Platalea regia, *Gould*, Proc. Zool. Soc., part V., p. 106.

The first authentic record of the occurrence of this fine Australian bird in New Zealand is contained in my paper on the subject, read before the Wellington Philosophical Society in July, 1876 (Trans. N.Z. Inst., Vol. IX., p. 337) based on a specimen obtained at Manawatu, forwarded to me by Mr. C. Hulke, and subsequently presented by myself to the Colonial Museum.

? Mergus australis, *Hombr. and Jacq.*, Ann. des Sci. Nat., 1841, p. 320.

In the communication already noticed, Baron von Hügel writes:—"I procured a pair of Mergansers with a few other skins in Invercargill, from a man who had just returned from a surveying trip to the Auckland Islands. He had not even turned the skin after taking it off the body; but as soon as I saw the back through the opening, and felt the beak through the skin of the neck, I knew what I had. * * * * I have compared this *Mergus* with the original description of *Mergus australis*, in the voyage of the 'Astrolabe'; from it I find that either the description is a very poor one, or my two birds must belong to a new species. But what agrees well, and made me first think they were an immature pair of birds, is the lower surface of the body, which, instead of being white as in *M. serrator*, is of a dull slaty grey, variegated with white bands (the feathers being edged with white). The whole plumage is very dark, approaching black on the back, the crest well formed, and the size, I fancy, considerably smaller than the British red-breasted Merganser (*M. serrator*). From the great difference in size and brightness of colouring in bill and feet, I deem them to be male and female; but in plumage there is little difference. The birds were killed the latter end of November last, and I procured them on the 27th of the following month."

Stercorarius antarcticus, *Gray*, Gen. of Birds, III., p. 653.

A living example in my possession, obtained at Waikanae, in the North Island. (See Trans. N.Z. Inst., Vol. X., p. 207.)

Stercorarius parasiticus, *Buller*, Birds of New Zealand, p. 268.

Three more examples have been obtained since the capture mentioned in my work.

Diomedea cauta, *Gould*, Proc. Zool. Soc., Part VIII., p. 177.

Prof. Hutton added this bird to the New Zealand avifauna, on the authority of a specimen captured at Blueskin Bay, in Otago, and in last year's volume of Transactions, I described very fully an adult female, taken on the beach near the Wellington Pilot Station, and brought to me alive.

PROCELLARIA AFFINIS, *Buller*, Trans. N.Z. Inst., Vol. VII., p. 215.

SP. NOV. Supra saturatè cinereus ; dorsi plumis et supra-caudalibus nigro terminatis ; alarum minimis et alâ spuriâ nigricanti-brunneis ; primariis extùs nigricanti-brunneis, intùs albis ; secundariis pallidè cinereis, albo angustè marginatis, basaliter albis ; rectricibus saturatè cinereis, duabus externis intùs albidis ; fronte albâ cinerascenti-nigro variâ ; regione suboculari conspicuè cinerascenti-nigrâ ; facie laterali guttureque albis ; pectore imo et abdomine cinereis plumis basaliter albis ; corpore reliquo subtùs albâ, pectoris lateribus cinereo lavatis, hypochondriis et subcaudalibus inferioribus cinereo variis et minutè transfasciatis ; subalaribus albis, exterioribus conspicuè nigricantibus : rostro nigro : pedibus sordidè flavis, digito externo et membranis interdigitalis nigris.

Dr. Finsch suggests that my *P. affinis*, as described above, may turn out to be *P. mollis*. I am unable at present to adopt this view, and for the following reasons :—

Procellaria mollis (the soft-plumaged petrel) was discovered by Mr. Gould, who first described it in the Annals and Magazine of Natural History (Vol. VIII., p. 363), and afterwards figured it in his Birds of Australia, Vol. VII., pl. 50. In his Handbook, at page 454, Vol. II., he has given a full description of the adult bird, from which I take the following particulars, by way of comparison :—Total length 13½ inches; wing 9¾ ; tail 5 ; tarsus 1⅜. My bird has an extreme length of 13 inches, the wing (from the flexure) measures 10·5, the tail 4, and the tarsus 1·2. It will be seen, therefore, that taking the two birds to be of somewhat equal size, (the length of a dried specimen being always an uncertain measurement), *Procellaria mollis*, with a wing nearly an inch shorter than *P. affinis*, has a decidedly longer tarsus and the tail a full inch longer. In a group of birds, where the species are so closely allied, this test of relative proportion in the functional parts is, I consider, a sound means of discriminating species. The plumage of *P. affinis* has a close general resemblance to that of three other allied species, forming together, as I have before pointed out, a very natural group or sub-genus. In the full description which I have reproduced above, there are some details of colouring which are, I think, due to immaturity, but the general plumage comes nearer to *P. cookii* than to *P. mollis*, although in other respects, as pointed out in my original description of the new bird, the two forms are specifically distinct and easily discriminated.*

* Since writing the above, I have received from Mr. C. H. Robson a Petrel answering exactly to my *P. affinis*, with the slightest possible variation in the measurements. This was obtained at Cape Campbell ; but Mr. Robson writes me (under date June 3) that he has secured another, which struck the Moeraki Lighthouse in thick weather and was killed.

PROCELLARIA MOLLIS, *Gould*, Ann. and Mag. Nat. Hist., Vol. XIII., p. 363.

Dr. Finsch has added this species to our list on the authority of a specimen captured by the Novara Expedition. After what has been said above, the identification (in the absence of measurements) may be open to question, as between this species and *Procellaria affinis.*

PROCELLARIA CÆRULEA, *Gmel.*, Sys. Nat., I., p. 560.

In my account of this species* I referred to the scarcity of specimens in the colony, the Auckland Museum alone at that time possessing it.

I received last year a specimen in very perfect plumage from Mr. C. H. Robson of Cape Campbell.

It is readily distinguished by the scapulars being edged and the tail-feathers broadly tipped with white.

PRIOCELLA ANTARCTICA, *Gmelin*, Syst. Nat., I., 565; Sharpe, App. Zool. Ereb. and Ter., 1875, 37.

I am in doubt as to the propriety of admitting this species into our avifauna, the specimen described by Dr. Hector† having been shot in lat. 46° S., long. 118° 9″ E., or "about 1,000 miles west of Tasmania, and in the latitude of Otago." It was included among the 'Birds of New Zealand' in the "Voyage of the 'Erebus' and 'Terror;'" and one or more of the five specimens in the British Museum are said to have been captured in our seas, but the evidence is by no means complete.

PHÆTON RUBRICAUDA, *Bodd.; Gould*, Birds of Austr., VII., pl. 73.

The claim of this species to be considered a New Zealand inhabitant is fully discussed in my paper of the 12th January last (Trans. N.Z. Inst., Vol. X., pp. 219–220).

PLOTUS NOVÆ-HOLLANDIÆ, *Gould*, Proc. Zool. Soc., part XV., p. 34.

The occurrence of this Australian species in New Zealand was recorded by me in October, 1874 (Trans. N.Z. Inst., Vol. VII, p. 217).

PHALACROCORAX FINSCHI, *Sharpe*, Ibis.

Mr. Bowdler Sharpe has distinguished, under the above name, a specimen from New Zealand, in the British Museum, differing from *P. brevirostris* in having a white spot on the wing-coverts. (See my notes, on a hitherto undescribed form, in Trans. N.Z. Inst., Vol. VIII., p. 197, and Vol. IX., pp. 338–340).

PHALACROCORAX CHALCONOTUS,‡ *Gray*, Voy. Err. and Terr., Birds, p. 20, pl. 21.

Dr. Finsch has identified an example of this species, forwarded to him by Prof. Hutton, from Otago.

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* Birds of New Zealand, p. 306. † Trans. N.Z. Inst., Vol. IX., p. 464.

‡ My description of this species, in the "Birds of New Zealand," is from the type in the British Museum.

EUDYPTES VITTATA, *Finsch*, Ibis, 1875, pp. 112–114.

? Aptenodytes papua, Vieill. (nec Forst. nec Gmel.) Gal. Ois. II., p. 246, (nec diagn.), tab. 299.

This is a new species from Otago, and I believe the type is in the Dunedin Museum.

EUDYPTES SCHLEGELI, *Finsch*, Trans. N.Z. Inst., Vol. VIII., p. 240. (= *E. diadematus*, Schleg.)

This form has been added from the Macquarie Islands.

Another penguin referred by Schlegel to *E. diadematus* but identified by Finsch as *E. chrysolopha*, Brant, is said to have come from New Zealand, but only on the authority of a dealer.

EUDYPTES ATRATA, *Hutton*, Ibis 1875, p. 112.

This very distinct species was received by Prof. Hutton from the Snares. The jet black colouration of its under surface separates this form from all the other known species, and its massive deep bill, its very small hind toe and long tail, afford other distinguishing characters. In size it is equal to the well-known crested penguin *(Eudyptes pachyrhynchus)*.

? EUDYPTULA ALBOSIGNATA, *Finsch*, Proc. Zool. Soc. 1874; et Trans. N.Z. Inst., Vol. VII., p. 236.

I have already stated* my reasons for considering this a mere variety of *Eudyptula minor*, but Dr. Finsch still believes in its validity as a species. The only differences pointed out by the learned doctor are, a patch of white on the upper tail-coverts, and a strongly marked peculiarity in the colouration of the flippers.

ART. XLIX.—*Further Contributions to the Ornithology of New Zealand.*

By WALTER L. BULLER, C.M.G., Sc.D.

[*Read before the Wellington Philosophical Society, 9th September*, 1878.]

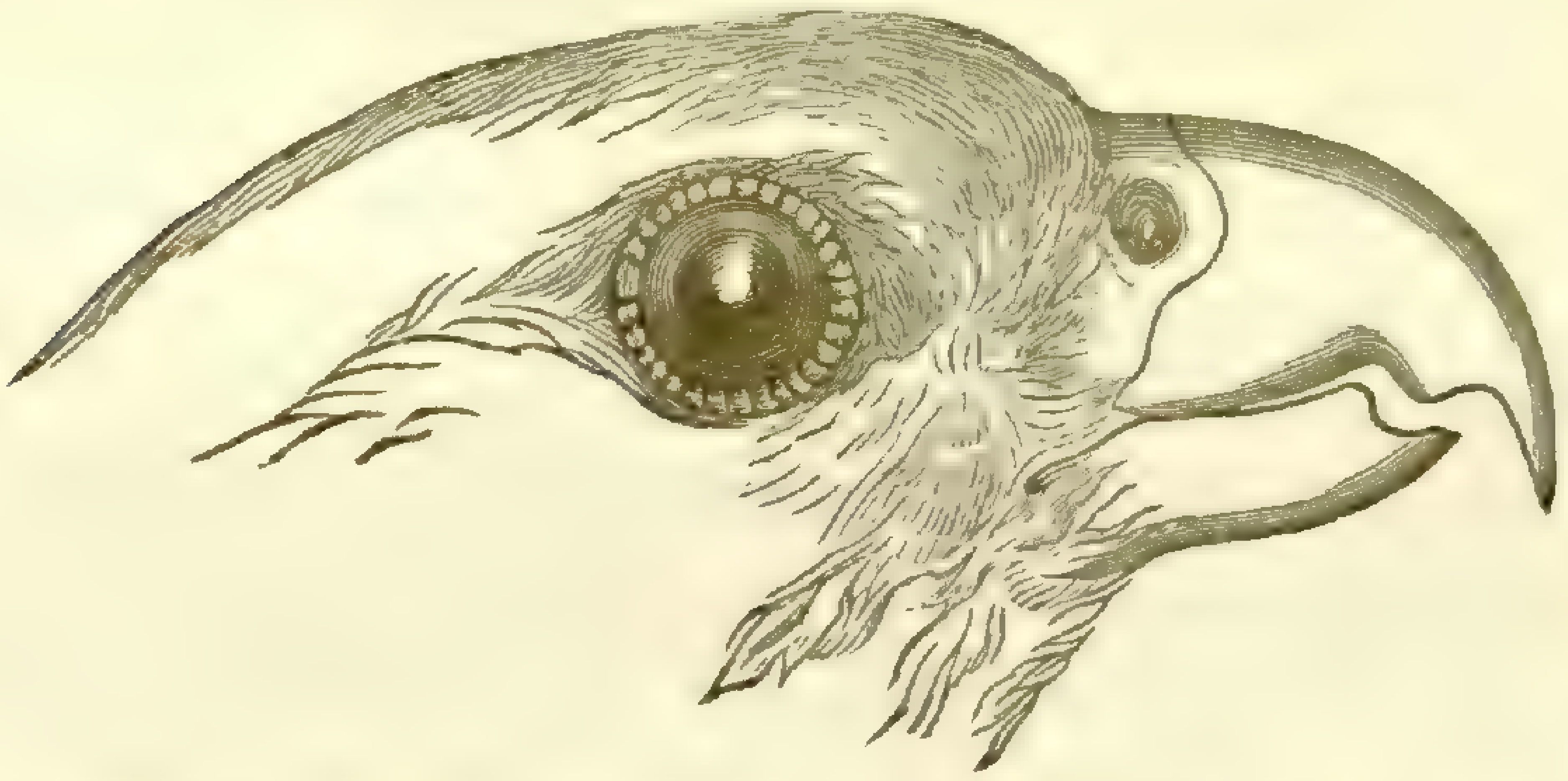
HIERACIDEA FEROX, *Peale*.—Bush Hawk.

IN Volume VI of our Transactions, page 113, I pointed out why, in my opinion, Mr. Sharpe was wrong in proposing to substitute *Hieracidea australis* for the above name, in his communication to 'The Ibis,' 1873 pp. 327–330. In his official catalogue of the Accipitres in the British Museum, he not only gives *H. australis* the precedence, but commits (as I venture to think) the further error of making it a "sub-species," whatever that may mean, of *H. novæ-zealandiæ*. The two birds are either specifically distinct, as

* Trans. N.Z. Inst., Vol. VII., p. 210.

I and others at present believe, or they belong to one and the same species, as contended for by Professor Hutton. On this point we are still waiting for further evidence, but unfortunately both the large and small forms are becoming so scarce that there are few opportunities of examining fresh specimens.

Mr. Sharpe has adopted Bonaparte's genus for our bird, merely altering the termination for classical accuracy and making it *Harpa*. He has given a woodcut of the foot, but has not diagnosed the genus. As he has treated the Australian genus *Hieracidea* in the same manner, it may be inferred that the difference in the arrangement of the scutellæ is the only ground for separating the genera. It seems to me, however, that as a distinguishing generic character this is somewhat uncertain. On comparing Mr. Sharpe's figure of the foot of *H. australis* with that given by me in Volume VI. of Transactions (facing page 214), it will be seen that there is a considerable amount of divergence. The following very truthful woodcut of the head of our bird will show its close relation to the Australian form, familiar to us as *Hieracidea berigora.*



Mr. Sharpe, at page 420 of his Catalogue, cites Gould, P. Z. S., 1837, page 141, for the genus *Ieracidea*, of which *H. berigora* is the recognized type. I have not access here to the early proceedings of the Zoological Society, but I find that Mr. Gould himself cites his Syn. Birds of Austr., part III., as the earliest authority for *Ieracidea berigora*, and the Proc. Zool. Soc., June 25, 1844, for *Ieracidea occidentalis.*

On the subject of the systematic position of our bird, Dr. Finsch has the following remarks, which I have translated from the German of the "Journal für Ornithologie" for March, 1872:—"*Falco novæ-zealandiæ* must be ranged among the Tree-falcons, and follows next in order to *Falco femoralis*, having, like the latter, a long tail, which is only half covered by the wings. * * * Third primary longest; second shorter and somewhat longer than fourth; first and fifth equal. Tarsi covered in front with ten sexagonal scutes in double rows. Middle toe very long, being with the claw nearly as long as the leg; lateral toes equal, the points of their claws scarcely reaching to the base of the middle-toe claw. A subgeneric distinction appears justifiable."

Circus gouldi, *Bonap.*, N.Z. Harrier.

It is worth recording that the Harrier will sometimes pursue on the wing. Riding along the road near the Whenuakura river, I observed a kahu pursuing a small bird (apparently a ground lark) high in the air. The pursuit was continued for a considerable time, the hawk making frequent swoops and the small bird eluding its grasp by suddenly altering its course, and thus gaining on its pursuer. When nearly out of sight the hawk was joined by another, both in pursuit of the same bird, from which circumstance I conclude that the raptor was foraging for hungry ones at home. This might account for the eagerness of the pursuit, and for a mode of chase which I have never observed before during a very long acquaintance with this species.

Platycercus rowleyi, *Buller*, Trans. N.Z. Inst., Vol. VII., p. 220.

So many specimens of this small form have been obtained in the South Island (whereas it never occurs in the North) that I think it may safely be admitted into the list of true and accepted species.

I have been looking over my notes on the series of this group in the British Museum, and I find that there is an appreciable difference in size between my bird and the type of Gray's *Platycercus aucklandicus*, which is, I believe, only a small example of *P. novæ-zealandiæ*.

As the notes to which I have referred may be useful for reference, I have transcribed them from my pocket diary.

British Museum Collection.—My examination of the types gives the following results:—*Platycercus aucklandicus* not distinguishable from *P. novæ-zealandiæ*, but smaller than ordinary examples; beak decidedly smaller, being of same size as in *P. auriceps*, but lighter at the base; ear-spots indistinct; frontal spot less extensive, but of same colour as in *P. novæ-zealandiæ*. *P. malherbii* = *P. auriceps*, but smaller than average specimens of the latter. *P. pacificus* similar to *P. novæ-zealandiæ* but much larger, with a more robust bill. *P. erythrotis*, from Macquarie Islands, = *P. pacificus*, but with lighter plumage. *P. forsteri* = *P. novæ-zealandiæ*, with the thigh-spots accidentally absent. There is another specimen marked "Platycercus forsteri," to which I shall refer again presently, in very different plumage. *P. cookii* = *P. pacificus*. *P. unicolor*, a much larger and very distinct species. (See my remarks in Trans. N.Z. Inst., Vol. VI., p. 121). *P. rayneri*, from Norfolk Island, is like *P. pacificus*, but larger and with a more powerful bill; the frontal spot is more extensive but lighter in colour; ear-spot small and obscure as compared with *P. novæ-zealandiæ*. I think we may pretty safely conclude that *P. rayneri* is in reality *P. pacificus*, although the British Museum specimen is both larger and lighter coloured than ordinary specimens of the latter. *Platycercus ulietanus*, from the Society

Islands, is very distinct in appearance from all those enumerated above. The so-called "*P. forsteri*," referred to above, labelled as from the main island Otaheiti, appears to hold an intermediate position between *P. ulietanus* and *P. pacificus*. It has the general plumage of *P. pacificus* but of much duller tints, mixed with brown on the upper parts and clouded with a colder green on the under parts. It wants the crimson vertex; but there is a frontal patch of brownish black corresponding to the colour of *P. ulietanus*, which changes to crimson in front of the eyes; behind which, also, there is a small obscure spot of dull crimson. It has the concealed nuchal patch of yellowish white, which is found in *P. pacificus*: while, on the other hand, it has the bright crimson rump which is characteristic of *P. ulietanus*. The tail has a dingy, washed-out appearance, and the colours of the plumage generally are very undecided. The bill and feet are exactly as in *P. ulietanus*, of which species this bird may be an accidental variety, or possibly, a hybrid. There is a specimen of our *P. novæ-zealandiæ*, exhibiting much bright yellow mixed with the green on the abdomen and under tail-coverts. It likewise has the thigh-spots very large and bright; the rump stained, and the tail obscurely banded on the upper surface with dull yellow. Another (collected by Strange) has a single bright yellow feather on the abdomen, and, according to the collector, the irides also were yellow.

NESTOR MERIDIONALIS, *Gray*.—Kaka Parrot.

A curious circumstance in the natural history of the kaka has lately come to my knowledge. At a certain season of the year, when this bird is excessively fat, large numbers of them are found washed ashore in Golden Bay, or on the Spit which runs out from it. They are generally dead, but if not, are so exhausted as to be unable to take wing. The apparent explanation is that the kakas in their migration across Cook Strait, which is widest at this part, are unable to maintain the long flight, owing to their fat and heavy condition, and fall into the sea. The set of the current being towards Cape Farewell, the bodies of the perishing birds are swept in that direction, and finally cast ashore.

HALCYON VAGANS, *Gray*.—N.Z. Kingfisher.

On driving round Porirua harbour on the 19th July last, I noticed an unusual number of kingfishers perched on the rocks along the beach, and on the telegraph wires stretched across the numerous little bays. They were evidently attracted by the shoals of little fish that were frequenting the shallow water at the time; and at one spot I had an ocular demonstration of my argument with Captain Hutton,* which I should like him to have witnessed. "Ten little kingfishers sitting in a row" were in possession of

* Trans. N.Z. Inst., Vol. VI., p. 129.

a short span of telegraph wire overhanging the water, and, one after the other, they were dipping into the shallow sea-water in pursuit of fish. Sometimes two or even three of them would dip at the same moment, raising a tiny splash all round, and then mount again to the wire or fly off to the shore with their finny prey.

In further illustration of the piscivorous habits of this bird it may be mentioned that Mr Brandon, of this city, has an indictment to file against the kingfisher for robbing the fountain in his garden of goldfish.

I am not aware that our kingfisher is ever nocturnal in its habits; but on a recent occasion, when travelling by coach along the banks of the Manawatu River, about 2.30 a.m., it being a cloudy night and quite dark, I heard the loud call-notes of this bird with startling distinctness. Probably it was a sleeper disturbed by the passing of the coach; although under these circumstances birds, as a rule, betake themselves off in silence to another roosting place.

Heteralocha acutirostris, *Buller*.—The Huia.

To the long list of albinoes among New Zealand birds already recorded, I have now to add a very remarkable one. I have received from Captain Mair some feathers which have much the appearance of the soft grey plumage of *Apteryx oweni*, although of course the structure is different, but which are in reality from the body of a Huia. I hope to receive the skin for examination, but in the meantime I will give a quotation from the letter forwarding the feathers:—"Old Hapuku, on his death-bed, sent for Mr. F. E. Hamlin, and presented him with a great *taonga*. This has just been shown to me. It is the skin of a very peculiar Huia, an albino I suppose, called by the Hawke's Bay natives 'Te Ariki.' I send you a few feathers. The whole skin is of the same soft dappled colour, but the feathers are longer and softer. The bill is nearly straight, strong, and full length. The wattles are of a pale canary colour. The centre tail-feather is the usual black, while the four on each side are the beautiful grey colour. These birds are well known to the Huia-hunting natives of Hawke's Bay, and to possess an 'Ariki' skin one must be a great chief. The specimen I have described was obtained in the Ruahine mountains."

Eudynamis taitensis, *Sparrm.*—Long-tailed Cuckoo.

The range of this species has been extended to the Friendly Group, Dr. Finsch having identified a young male in the spotted dress in a collection of birds from the Island of Eua.

The long-tailed cuckoo remains with us from October to February, and breeds in this country; but we have yet a good deal to learn about its peculiar habits and nidification.

It is very pleasant to hear a pair of these birds answering each other for hours together from the lofty tops of neighbouring trees. Indeed, I have

observed that it is habitually stationary, for it may often be heard uttering its long, plaintive scream for a whole day in the same tree, but always quite out of view. During the quiet summer nights of December its far-off cry may be heard at intervals till break of day, varied only in the earlier watches by the solemn hooting of the morepork.

ZOSTEROPS LATERALIS, *Reich.*—Silver-eye.

Referring again to the migration of *Zosterops* from the South Island in 1856, it may, I think, be assumed that the large flights which came across the Straits made the island of Kapiti in their passage, and tarried there for a time before they reached the North Island. It will be remembered that the flocks which afterwards spread over the province appeared first at Waikanae and Paekakariki, on the lee shore from that island. I found *Zosterops* excessively abundant at Kapiti during my visit in April. Every bush swarmed with them, and sometimes fifty or more would crowd together in the leafy top of a stunted karaka, warbling and piping in chorus, producing sylvan music of a very sweet description. They appeared to be feeding on a species of *Coccus* that afflicts that tree.

The large numbers of these birds that appeared in flocks at Waikanae and Otaki in the early part of June last would seem to indicate another incursion from the South Island at that date.

GERYGONE FLAVIVENTRIS, *Gray.*—Grey Warbler.

A nest of this little bird in the Canterbury Museum, of rather larger size than usual, presents the uncommon feature of several soft Emeu feathers, as well as some bright coloured feathers of the domestic fowl, worked into the felting, among the ordinary substances (see fig. 1); another in the same collection is ornamented with the long dry leaves of the red gum (*Eucalyptus*), around and among which the round structure is most cleverly built (see fig. 2). There is another, showing very conspicuously the porched entrance, described in a former paper (see fig. 3). The form of the nest appears to be generally adapted to circumstances of locality, etc., and the accompanying woodcut will show how variable it is.

Fig 3 *Fig.* 2. *Fig.* 1.

HYLOCHELIDON NIGRICANS, *Gould.*—Australian Tree Swallow.

Mr. Cook has added to his former communication the following (under date Blenheim, 23rd August):—" I have no further notice to give of the

appearance of the Tree Swallow, except that I saw what I believe to be the same bird about half a mile from where I saw it before, a month after its first appearance. Although I have kept a good look out for it since, I have not again seen it. If I mistake not, I have often seen the Tree Swallow on the Wimmera, in Australia. Its nesting place was in hollow logs; sociable in nidification; a dozen or more nests of clay, bottle shaped, and built touching one another." My correspondent's remarks on the nesting habits refer evidently to the Australian martin, which builds bottle-shaped nests of the kind he describes; sometimes in the cavities of decayed trees, often in clusters attached to the perpendicular banks of rivers, the sides of rocks, or other prominences, and generally in the vicinity of water. The Tree Swallow, on the contrary, as Mr. Gould informs us, breeds in the holes of trees, forming no nest but depositing its eggs, from three to five in number, on the soft dust, or pulverised wood, generally found in such places.

The species has a rather wide range, being migratory over the southern portion of Australia and Tasmania, arriving in August and retiring northwards on the approach of autumn. Mr. A. R. Wallace brought specimens from the Aru Islands; and other localities have been recorded.

It visits the towns, in company with the common swallow; and I remember seeing it comparatively numerous in and about Sydney, during a visit there in August, 1871.

HIMANTOPUS ALBICOLLIS, *Buller*.—White-necked Stilt.

Through the kind attention of Mr. C. H. Robson, I have received from Cape Campbell a Plover clearly referable to the above species. From the enlarged condition of the tarsi below the joint, it is evidently an immature bird, and this will account for the crown and hind neck being tinged or faintly mottled with grey, these parts being wholly white in the adult. The flanks, rump, and under tail-coverts are clouded with black; tail-feathers on their inner web and towards the base white; the rest of the plumage as in my type.

ANAS SUPERCILIOSA, *Gmel*.—Grey Duck.

As an instance of how the grey duck may be tamed by protection, I may mention that, on October 26, I saw a pair with eleven young ones within a few yards of Travers' Bridge, Avon, almost in the heart of Christchurch, and several other pair in the vicinity. It has generally been found almost impossible to domesticate this bird owing to its tendency to revert to the wild state. But lately, when riding between Woodville and the Manawatu Gorge, I saw, at a "cockatoo homestead," a flock of domestic ducks on the roadside, and with them a perfectly tame *Anas superciliosa*, apparently a bird of the first year. It was distinguishable at a glance from the rest, by its manner of walking, carrying its head low or in a crouching attitude. Its smaller size and more slender form also betrayed it, before I came near enough to examine the plumage.

Anas chlorotis, *G. R. Gray.*—Brown Duck.

An albino form of this duck, the whole of the plumage being of a dull cream colour, with obsolete markings, was shot in the Horowhenua Lake in June last.

The brown duck is far more plentiful than is generally supposed; but, being a nocturnal feeder, it is not so commonly seen as the grey duck and the "black teal" or pochard. It always retires up the creeks in the woods during the day, or conceals itself among the sedges and vegetation which usually fringe the inland watercourses and lagoons. At Horowhenua, for example, where they are particularly abundant, you rarely surprise one, except by means of a dog, during the heat of the day. But after sunset they begin to collect on the surface of the lake, emerging in pairs from their concealment, swimming down to the mouth of the bush creek, and then taking wing to the place of rendezvous. They then form into flocks, sometimes of considerable size, and are on the alert, feeding about the lake all night long. When hunting for its food, it makes a peculiar and rather musical sniffing noise.

Querquedula gibberifrons, *Bonap.*—Little Teal.

This duck is very plentiful in some of the sulphur springs at Ohinemutu, and likewise at Rotomahana, where, as Captain Mair informs me, he once killed as many as eleven at a single shot on the water. It sometimes swims in pairs, but usually associates in small flocks of a dozen or more. It is easily distinguished from all the other species by the conspicuous white bar on the wings.

Stercorarius antarcticus, *Gray.*—Southern Skua.

The living example of this fine Skua-gull, referred to in last year's volume, is still an inhabitant of my garden, where, after much preliminary persecution, it now tolerates the companionship of a grey sea-gull (*Larus dominicanus*). The history of this bird is somewhat remarkable. About a year and a-half ago it was captured somewhere in the vicinity of Kapiti, and came into the possession of the Hon. Wi Parata, who kept it in his *marae* till it became quite tame. Being injured in the wing it was unable to fly, but having made its escape, it travelled some ten miles up the coast, and was recaptured by some natives at Otaki. It remained there some three months, and then made a fresh start northwards. Its next stage was Horowhenua, where it was caught and taken inland to Hector McDonald's homestead. Here it became an inmate of the farm-yard, and appeared to get quite reconciled to its changed mode of life. It fraternized with the dogs and poultry, sharing their food and occasionally devouring a chicken. But one day, after a fight with a rival turkey, in which it appeared to come off second-best, it travelled to the coast, a distance of some four miles, and

then turned its head northwards again. A week or two later it was found near the mouth of the Manawatu River, and carried inland to Foxton. It commemorated its arrival by swallowing some ducklings and chickens. It was then passed on to a settler "up in the bush," where it killed and devoured a well-grown pullet. I arrived just in time to prevent its being sacrificed to the anger of the good housewife. Thence it was deported by coach to Wellington, making its escape on the Manawatu sands, *en route*, and detaining Her Majesty's mails while being recaptured. After keeping the bird caged for a few days I turned it loose in the garden, where it has remained for upwards of six months without any attempt to get away. Christened "Peter" by the children, he has become quite tame and familiar, answering to his name and taking food from the hand. He has selected a sunny spot on high ground, as an outlook station by day and as a sleeping-place by night. He wanders over the place freely, looking for worms and grubs, and during the heat of the day seeks the shade of some bushy shrub. He is almost omnivorous, but gives the preference to fish and meat. On a dead bird being offered him he runs off with it in his beak, then holding it down with his feet, plucks the feathers off and devours the flesh. On throwing him a blight-bird (*Zosterops lateralis*) he bolted it, feathers and all. His capacity for swallowing fish is something astonishing, his crop becoming greatly distended. He has the power of regurgitating his food, and will sometimes reproduce from his throat a bone of marvellous size, the wonder being how he ever managed to swallow it. Although not habitually a nocturnal bird, he sometimes gets very excited after dark, hurrying about the garden with outstretched wings and uttering a peculiar cry as if being suffocated. At other times he emits at intervals a note like the crowing of a pheasant. During the day Peter is noiseless, except when quarrelling with the sea-gull or disputing possession of a bone with the dog, when he has a short peevish note, quickly repeated. His first encounter with a tame cockatoo in the garden was quite ludicrous. He first played the *role* of assailant, but the moment his opponent erected his crest, Peter quailed and ran away. After this they established friendly relations with each other, often basking together in the sun, and drinking from the same fountain.

I have mentioned before that this capture is the first known instance of the occurrence of the Southern Skua in the North Island. I have lately, however, met with another on the West Coast. Travelling by coach we found one, apparently a fine male in full plumage, on the sandy beach, not far from the Otaki river. He was evidently worn out with fatigue, and would not rise till the coach was within a few yards of him; then rising with a slow and laboured flight, he proceeded a few hundred yards and alighted

again on the beach, repeating the operation again and again till the coach reached the Paikakariki, a distance of some twenty miles. Any bird of ordinary intelligence would have made a circuit and got behind the pursuing coach. But the Skua ashore was evidently out of his latitude; and this was made more apparent by the manner in which the sea-gulls (of both species), his hereditary victims at sea, pursued him in the air and buffeted him. As is well known this bird usually subsists by plunder, pursuing the gulls and compelling them to disgorge their food. Here, however, the conditions were changed, as I myself had an opportunity of observing from the box-seat. The skua had alighted in a shallow beach-stream and was ducking its body in the water when a fine old hawk *(Circus gouldi)* with hoary white plumage, suddenly appeared from the sandhills and swooped down upon the intruder. The skua, without making any show of resistance, instantly disgorged from its crop the entire body of a diving petrel *(Pelecanoides urinatrix)*. The hawk, balancing himself for a moment with outspread tail, dropped his long talons into the stream and clutched up his prey without wetting a feather of his plumage, and then disappeared among the sand-hills, while the terrified skua hurried off, only to be pursued again by the clamorous sea-gulls. Thus we have examples of "retributive justice" even among birds.

The flight of this bird is heavy, and performed by slow regular flappings of the wings, with the shoulders much arched. It possesses, however, the faculty of turning quickly in the air, as I observed when the gulls were in pursuit. On the wing the white mark across the primaries is very conspicuous, but it is not sufficiently apparent to distinguish the bird when the body is at rest.

PRION VITTATUS, *Lacép.*—Broad-billed Dove Petrel.

As already stated in my paper on *Prion banksii*, after boisterous weather in July, I found the sea-beach between Waikanae and Manawatu strewn with the dead bodies of *Prion turtur* and *P. banksii*, the former species preponderating. Having occasion to make the journey again after stormy weather in the early part of the following month, I found the strand strewn with even a larger number of bodies, but, strange to say, nearly all belonging to the very broad-billed species, *Prion vittatus*. Out of twenty-four specimens picked up in succession, there were only three of *Prion turtur* and none of *P. banksii*. Scores of others which I was able to determine from the box of the coach, belonged to *P. vittatus*, with here and there a *P. turtur*, but not a single example could I find of the intermediate form so plentiful a month before. It may be inferred from this singular fact that the species do not intermingle, but fly in separate communities. I have observed flocks of *Prion turtur* on the wing together numbering many

hundreds. *Prion vittatus* and *Prion banksii,* in like manner no doubt, keep to themselves, for it is evident that the flocks in the vicinity of our coast when caught in the fatal storm, on the occasion I have referred to, were composed almost exclusively of *Prion vittatus.*

I opened a large number of these birds for the purpose of ascertaining on what they had been feeding. As might have been expected with storm-tossed fugitives, the stomachs of many were quite empty. In others there was a black mass of comminuted matter, and in two or three of them I detected among this matter what appeared to be the beaks of a very minute cephalopod.

Phalacrocorax varius, *Gml.*—Pied Shag.

Captain Mair writes me, under date 20th November:—"I went to Whale Island ten days ago. The sea-birds building there are very interesting. There are some colonies of white-breasted shags on this island as well as at Rurima—only the one species. I found the young in every stage, from partly developed ones in the egg to young birds just ready for flight, all with white breasts and bellies. I am going to Rotoiti in a few days to have a look at the shaggery there.

"On the island I saw some thirty crane *(Ardea sacra),* and I found a number of their nests in a cave. Those that were fully fledged were a beautiful light blue colour, with bright yellow legs. It was very funny to watch them flying into the high trees, perching among the shags, and looking very gawky; then, presently, the shags, with loud guttural noises, would sally forth, chasing them far and wide.

"I may add that, although there are no tuis on the islands, korimakos (*Anthornis melanura*) are very plentiful. It was really delightful to see and hear them again. They abound in numbers in the shrubbery, and hearing them sing at daylight, carried one back in spirit to one's boyhood, at the North, thirty years ago!"

Art. L.—*Memorandum of the Keá.* By the Hon. Dr. Menzies, M.L.C.

[*Read before the Wellington Philosophical Society, 28th September,* 1878.]

In Dr. Buller's 'Birds of New Zealand' we learn that the habits of the "Keá" or Mountain Parrot, *(Nestor notabilis,* of Gould) are carnivorous; that it attacks and destroys living sheep, apparently at random. Recent observation leads to a belief that, in some localities at all events, it selects its victims and also its delicacies.

These birds, common on the high ranges, are not always to be found in the same localities, but appear to migrate from place to place in small flocks of a dozen or a score. Shepherds who have been for some time in charge of sheep on the higher ranges in Southland, say that the Keas attack sheep even when they are being gathered or driven along, invariably selecting fat sheep as the objects, and one particular point of attack. After a few days, during which the shepherds have to be on the alert, they disappear and are not again seen for days or even weeks in the same locality.

They suppose that these birds formerly fed chiefly on berries and the large white grubs abounding in mossy vegetation on the hills; and that after the country was stocked they, first by feeding on maggots and insects on dead sheep, and afterwards on the dead animals, acquired not only a taste for meat, but also a discrimination of the choice parts. By-and-bye they attacked living sheep, alighting on their backs, where their powerful-hooked upper mandible enabled them quickly to tear open the skin, and gain access to the fat about the kidneys, for which delicacy they appear to have a particular relish; after tearing away and consuming the kidney-fat of one, they flit away to attack another victim.

On some runs the loss from this cause is considerable. The sheep that have been wounded but yet have been strong enough eventually to shake off these birds, or have been otherwise rescued from them, usually pine and die. Many of these have been seen with their intestines torn and protruding from the wound in the back.

Of the probable number of sheep destroyed in this way, some idea may be formed from the facts observed during the last shearing season. Upon one run, on which about 30,000 sheep were shorn, above one hundred were found to have been torn by the Keá, and it was necessary to kill the greatest number of them. On this particular run the annual loss is unusually large. A proportion of the loss is no doubt attributable to the predaceous habits of this bird; for in such a rough country a very large proportion of the sheep that die are never seen, and of those that are discovered, decay will very often have obscured the cause of death.

These parrots frequent the higher ranges of mountains, such as the Takarahaka and Takitimo in Southland, where they are common. On the lower ranges, under 2000 feet, they are only occasionally seen, and up to this time do not usually disturb sheep depasturing below that elevation.

Art. LI.—*Descriptions of three new Species of* Opisthobranchiate Mollusca, *from New Zealand*. By T. F. Cheeseman, F.L.S., Curator of the Auckland Museum.

Plate XVI.

[*Read before the Auckland Institute, 22nd October*, 1877.]

From a number of new species of Opisthobranchiate Mollusca, collected in or near Auckland Harbour, I have selected for description the three following prominent forms :—

1. Pleurobranchus ornatus, n. sp. (Pl. XVI., figs. 1, 2.)

Body 3–4 inches long, broadly elliptical, depressed, nearly equally rounded at both ends, colour varying from pale buff to a clear reddish brown, with irregularly disposed blotches of a rich dark red-brown ; mantle large, extending over and concealing both head and foot, quite smooth, margin thin, entire ; dorsal tentacles short, stout, abruptly truncate, finely transversely wrinkled, approximate at their origin, but gradually diverging at their apices ; colour reddish brown tipped with white ; eye-specks black, placed a little distance behind the tentacles, embedded in the integument, but appearing through it ; oral tentacles united in front by a thin semicircular expansion which forms a veil concealing the mouth, and which is carried in advance of the foot ; mouth roundish, with fleshy lips ; buccal plates two, regularly reticulated ; odontophore with numerous rows of similar unciform teeth. Branchial plume placed in the groove between the foot and the mantle, very large, composed of about 22–24 pectinations; foot oblong, thin and flexible, pale waxy white.

Shell internal, ½ to ¾ inch long, squarish oblong, thin and membranous, semitransparent, slightly iridescent, closely marked with somewhat irregular concentric striæ or folds; colour varying from nearly white to pale pinkish or tawny brown. Spire minute, obscure, mouth occupying the whole of the undersurface.

My first specimens of this handsome species were obtained from under stones between tide-marks in Auckland Harbour ; where, however, it is by no means common. Near Waiwera and in some other localities on the Hauraki Gulf it is much more frequently met with. It is easily kept alive in an aquarium, but is very sluggish in its movements.

2. Pleurobranchæa novæ-zealandiæ, n. sp. (Plate XVI., fig. 3.)

Body oval, convex, thick and fleshy, smooth and lubricous to the touch, but the whole surface nevertheless covered with minute puckers and folds. Colour light grey, copiously streaked with irregular anastomosing lines of dark greyish-brown, and sprinkled with numerous minute and almost

microscopic white dots. Mantle smooth, not nearly so long as the foot, and not concealing the branchiæ, rather broader on the right side; oral veil broad, extending over and concealing the mouth, in front semicircular, and with a delicate fringed margin, but at each side produced into a short tentacle-like lobe; mouth large, round, in a state of rest concealed in the sulcus between the oral veil and the foot, but capable of being greatly protruded in a proboscidiform manner; buccal plates two, large, finely and regularly reticulated or faceted; odontophore broad, with numerous rows of similar unciform teeth; tentacles dorsal, wide apart, short and stout, projecting outwards, folded down the outer side, tips obliquely truncate; eyes minute, black, placed within the integument at the inner bases of the tentacles, quite internal, and not to be seen without dissection; foot long, extremely flexible, sole pale ashy grey; branchial plume often over an inch in length, and free for half that distance; pectinations about 17, finely ciliated; shell none; length 2·5 to 3·25 inches.

This species is very abundant in Auckland Harbour, usually affecting sandy or muddy localities. In the winter and spring months large numbers are often exposed at neap tides, having probably come into shallow water to deposit their ova. Captain Hutton, of the Otago Museum, informs me that he has collected the same species at Port Nicholson. It is hardy and not easily killed, and may be kept in confinement for a long time. When in a healthy state it is by no means inactive, crawling along by means of its muscular foot much more quickly than might be expected. It has a curious habit of floating in a reversed position, just under the surface of the water; and I have also observed it swimming by means of rather violent vertical undulations of its body.

3. ACLESIA GLAUCA, n. sp. (Plate XVI., fig. 4.)

Body from 3 to 5 inches long, about ovate when at rest, but capable of considerable extension, a little contracted behind the head, then elevated, and suddenly sloping to a point posteriorly; entirely covered with numerous simple and branched tentacle-like processes, the largest of which are sometimes eight lines long. Colour on the sides pale greyish-brown, passing on the back into a dull sea-green; the whole surface with numerous irregularly shaped black blotches that are largest on the back. Along the back there is also a double row of from 8 to 12 emerald-green specks, each surrounded with a zone of umber. Dorsal tentacles $\frac{3}{4}$ inch long, folded down the outer side so as to appear tubular, beset with filiform appendages. Labial tentacles similar in shape, but rather larger. Branchial cavity large, protected by the folded-in edges of the mantle, branchiæ quite internal; foot long and narrow, pointed behind, without side-lobes as in *Aplysia*, sole pale sea-green; mouth roundish, placed under the head; odontophore with very

numerous rows of simple hooked teeth; gizzard strengthened with large triangular calcareous plates; shell none.

Like many of the species of the allied genus *Aplysia*, this animal possesses the power of emitting a purple fluid from the edges of the mantle, but only in small quantity; and it may often be handled without anything of the kind being observed. All my specimens are from Auckland Harbour, and were obtained from rather sandy localities near the extreme verge of low-water mark.

EXPLANATION OF PLATE XVI.

Fig. 1. *Pleurobranchus ornatus.*
2. Shell of the same.
3. *Pleurobranchæa novæ-zealandiæ.*
4. *Aclesia glauca.*

Art. LII.—*Our Fish Supply.* By P. Thomson.

[*Read before the Otago Institute, 13th August,* 1878.]

I beg to lay before the members of the Institute the third and concluding series of my notes on the Dunedin Fish Supply.* I think enough has been done to show the times and seasons of the principal food fishes of this part of the colony; and if some one will take up a similar duty for a port in the north, say Auckland, and another for one in the middle of the colony, say Wellington, a very good idea may then be had of the whole question.

The most important event of the past year in connection with my subject, was the passing of an Act regulating Fisheries, by the Colonial Legislature. It may be thought presumptuous on my part, but I must take a little credit in having at least assisted in bringing this about. A little stir has been induced, both among the fishermen and the dealers, by the fact of some one being in their midst who was "taking notes." During the past year or two I have been in frequent communication with the dealers, as well as by paragraphs in the Press, urging the necessity of steps being taken to preserve the fisheries in the harbour from utter destruction, by either refusing to take from the fishermen any fish under a certain size, or agreeing among themselves to refuse dealing with those who persisted in bringing undersized fish to town. The Act was rather a surprise, as no one here knew of its introduction to the House until it had passed its second reading, and in the hurry at the close of the session there was no time for

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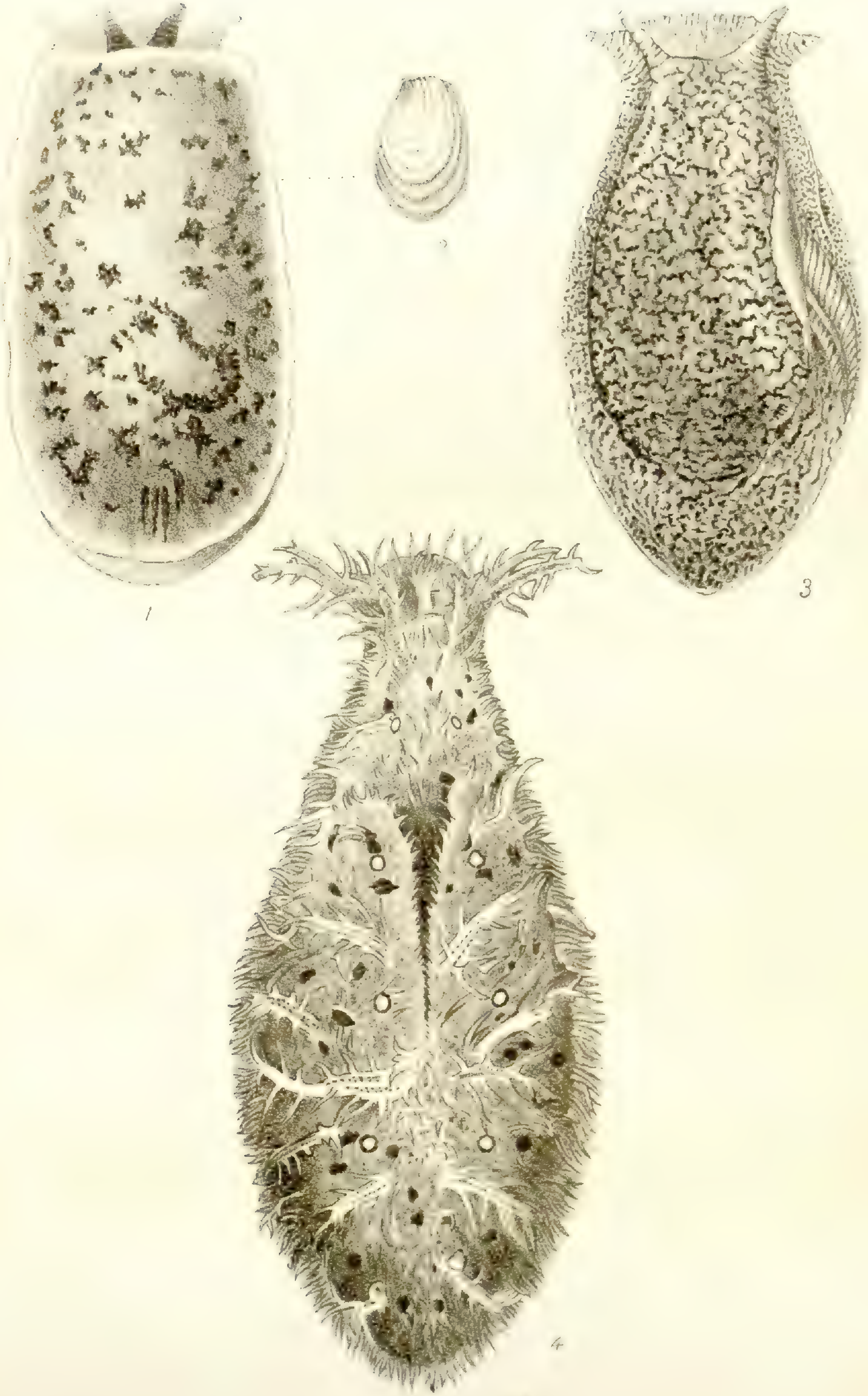
* *Vide* Trans. N.Z. Inst., Vol. IX., Art. LXVII. and Vol. X., Art. XLIV.



NEW OPISTHO-BRANCHIATE MOLLUSCA.

alteration. A synopsis of the Bill appeared in one of the Dunedin papers, and I wrote pointing out what I thought objectionable features. When a copy of the Act was procured, it was found to be very general in its details, and as far as Otago harbour is concerned, almost unworkable. When Ministers arrived in Dunedin, after the close of the session, no time was lost by the dealers in waiting on them and ascertaining the intention of the Government in the matter. Deputations explained what was wanted, and arrangements were made for a conference of all concerned, fishermen and dealers, which took place on January 5th. After a number of those present had expressed their sentiments on the matter, a memorandum was drawn up, setting forth the sizes of fish which were to be considered marketable. These sizes were:—That no flounders should be sold under nine inches long; no red cod under ten inches; no mullet under nine nches; and no garfish under fourteen inches—a penalty to be incurred for contravention. It was not considered advisable to make any regulations about the outside fishing, as it was thought that risk, weather, etc., were quite sufficient protection. After this it was thought there would be no grumbling at any steps that might be taken to carry out the objects of the Act, which are, so far, of a merely tentative nature.

Nothing has yet been done in the way of establishing a fish market in the city, but as the matter has now been taken in hand by that active and influential body, the Chamber of Commerce, it is to be hoped that a market place for the sale of fish, etc., will soon be in full swing.

The following table gives the details of the various fishes, taken day by day from the different shops in the town, as well as by inquiries at the jetties, Port Chalmers, etc. I have taken great pains with the table, and the information it contains may be taken as substantially correct.

Various other fishes occur, but at irregular intervals, and only one or two at a time. Among these I may mention the following as occurring most frequently:—The Whiting, *Pseudophycis breviusculus*, is got occasionally, as is also the Haddock, *Gadus australis*. The Granite Trout, *Haplodactylus meandratus*, occurs now and then. Quite a lot of Horse Mackerel, *Trachurus trachurus*, were brought to town in March last, only individual specimens being the rule previously. Occasionally a few Gurnard, *Trigla kumu*, may be seen in the shops, but they are very shy visitors. About the end of January, a few Tarakihi, *Chilodactylus macropterus*, were brought to market, so it must be enrolled as a summer visitor. That very dark-skinned fish, the Maori Chief, *Notothenia maoriensis*, of Dr. Haast, is not uncommon, but is rarely seen more than one at a time. The Herring, *Clupea sagax*, did not turn up during the past summer as usual. The Kingfish, *Seriola lalandii*, also put in no appearance this year.

Names of Fishes.		Number of Days in Market.													
Native or Settlers'.	Scientific.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Total.	Average for Three Years.
Hapuka, Groper	*Oligorus gigas*	..	4	14	21	16	19	16	19	18	23	7	..	157	153
Kahawai, Salmon ..	*Arripis salar*	..	..	..	..	..	4	..	1	..	..	..	..	5	3
Tamure, Snapper ..	*Pagrus unicolor*	..	..	..	..	..	1	..	1	1	1	..	..	4	2
Ling	*Genypterus blacoides*	2	..	1	4	2	12	3	7	9	17	7	15	79	90
Moki	*Latris ciliaris*	2	4	14	16	12	13	10	11	7	10	5	1	105	107
Kohi, Trumpeter	*Latris hecateia*	..	2	3	8	2	4	3	3	..	2	1	1	29	29
Mangu, Barracoota ..	*Thyrsites atun*	..	..	2	24	16	18	7	14	16	11	1	..	109	112
Hiku, Frostfish	*Lepidopus caudatus*	1	..	..	..	..	..	..	..	1	..	6	20	28	13
Pakirikiri, Blue Cod ..	*Percis colias*	11	9	6	15	1	5	2	1	1	5	5	4	65	84
Red Cod	*Lotella bacchus*	23	23	22	25	20	22	17	26	25	24	20	20	267	197
Sandling or Sandeel ..	*Gonorhynchus greyi* ..	4	5	4	2	1	..	1	3	5	4	2	4	35	41
Ihi, Garfish	*Hemiramphus intermedius* ..	2	..	15	13	1	5	1	..	1	..	..	1	39	33
Butterfish (true)	*Coridodax pullus*	1	..	5	6	1	1	1	3	2	2	..	1	23	9
Wrasse, or Perch	*Labrichthys celidota*	..	..	2	2	4	2	..	..	..	..	...	1	11	..
Parrotfish	*Labrichthys psittacula* ..	..	3	..	3	..	..	..	..	..	..	..	1	7	7
Spotties	*Labrichthys bothryocosmus* ..	2	1	13	19	12	16	19	22	23	11	7	9	154	81
Makuwhiti, Mullet, or Herring	*Agonostoma forsteri*	11	4	7	18	10	11	13	22	14	16	5	16	147	179
Whitebait	*Retropinna richardsoni* ..	..	..	1	..	..	..	..	..	1	..	..	..	2	2
Arara, Trevally	*Neptomenus brama*	8	1	1	7	5	5	18	22	17	13	11	2	110	107
Patiki, Flounder	*Rhombosolea monopus* ..	24	20	24	25	23	23	23	26	25	23	22	24	282	181
Sole	*Peltorhamphus n. zealandiæ* ..	1	..	..	..	1	1	..	4	..	2	..	2	11	20
Skate	*Raja nasuta*	3	1	2	1	1	..	..	..	3	7	4	1	23	17
Number of days on which there were no fish		1	..	1	..	3	2	..	..	1	..	1	1	10	21

Of the regular food fishes the following notes may be of interest :—

The Hapuka or Groper was in pretty regular supply from the close of September till towards the end of June. The demand for this fine fish is not half so great as it should be. It was in the market 157 days.

Ling has been in rather irregular supply during the year. For a few days this fish would be quite common, and then for a week or a fortnight there would be none at all, and this quite irrespective of the weather. Was 79 days in the market.

Kahawai was in good supply for a few days in January, and occurred again in March.

Snapper was brought to town in summer and autumn, but the catch was limited to a few individual specimens, all of good sizes.

Moki was constantly to be found in the market, a few days at a time, all through the year, though most numerous in the summer months. Was in the market 105 days.

Trumpeter was in rather short supply during the year, very few having been received from the southward. 29 days in the market.

The Barracoota made its appearance on the 29th October, when a solitary specimen was caught, followed by abundance on the 31st. It continued in season till the end of May, although one was caught by net in the Lower Harbour on the 19th of June. Was 109 days in the market.

A few Frostfish were caught (I should rather say picked up, for the fish is never caught in the ordinary sense of the word) in August, and again in April; but towards the end of June and nearly all July large numbers of this fish were brought to town, one dealer passing no fewer than 109 through his hands in a fortnight, mostly brought from the vicinity of Purakanui. On all the beaches to the west of the Heads, and away to the north, particularly about Moeraki, large numbers were got. Nothing is yet definitely known as to why this fish comes ashore in the peculiar way it does, but I may give you the latest theory as it appeared in one of the papers here a week or two ago. The writer said :—"The stranding of these fish is accounted for from the fact that, not being well supplied with fins, they swim with an undulating motion, like that of the leech, the head being elevated. In cold weather they follow their prey into shallow water, and when the tail touches the ground they become helpless, and are washed ashore." The writer was very easily crammed. It is a noticeable fact that all the fish are about the same size—4½ feet to 5 feet in length. In the market 28 days, being the longest known.

Blue Cod.—This staple fish was in fair supply nearly all the year, with the exception of some weeks in winter, when there was some severe weather, which put a stop to outside fishing. The supply from Stewart Island was very irregular. Was 65 days in the market.

Red Cod.—Both from inside and outside fishings; was in very regular supply, the shops being seldom without a few. Indeed, this fish is always to be had, and is in finest condition during the winter months, when pretty large takes of good-sized specimens are got from the outside fishery, those caught by the seine-net in the harbour being as a rule much smaller. Red Cod was in the market 267 days.

Sandling or Sandeel.—This delicate little fish is never very plentiful, but a few are generally caught in the seine-nets. Properly cooked, this is one of our finest food fishes. Was present 35 days.

Garfish was pretty plentiful during the spring and summer. In October immense numbers were brought to town, large shoals being present in the Lower Harbour for several days. In the market 39 days.

The true Butterfish was more frequently brought to town during the past year than ever before. Some of them were of pretty large size, and mostly netted among the rocks along the coast, and near Moeraki. 23 days in the market.

Wrasse, Parrotfish, and Spotties were often in the market, the latter especially being a regular seine-fish, and got along with Flounders, etc. There are two sorts of Spotty—a big and a little. The Wrasse and Parrotfish are mostly caught outside among the kelp, and with the Spotty are indiscriminately named Kelp-fish by the fishermen, though the term Butterfish is also given to the smaller sorts. Spotties in market 154 days.

The Mullet or Herring is to be had almost constantly, and is present in greater or less quantity the whole year round. At very irregular periods large shoals of the fish congregate in the Harbour, when they are caught by the net in immense numbers. This fish gives good sport with rod and line. Was 147 days in the market.

Trevally.—This excellent little fish is also a constant visitor, and may be had in quantity all the year round. Some pretty large ones are now and then to be seen. Was 110 days in the market.

That favourite fish the Flounder was in full supply nearly all the year. Latterly, I notice that the Flounders brought to town have increased in size a little; it is to be hoped that this will continue, and that the new Act will have some influence with those who catch them. 282 days in the market.

Soles are not very common, only those caught by the seine being brought to market. If trawling were introduced in suitable localities along the coast, the fish would be more plentiful. Was 11 days in market.

Skate was brought to market on 23 days. Those exhibited were mostly of small size.

I subjoin the following notes on the weather, incidents, etc., for the twelve months:—

August was characterised by cold and dull weather, with two or three

storms. Fish, with the exception of small Flounders and Mullet, were generally scarce.

September had very stormy weather at the beginning, which moderated gradually towards the end. The supply of fish sympathised with the weather, being very scarce at commencement, and improved towards the close.

October.—The weather was fine at the beginning, but stormy and irregular towards the close. There was a good supply of fish about the middle of the month. Butterfish were pretty numerous. On the 25th, very large hauls of Garfish were made in the Lower Harbour, and this fish was very abundant for some days. On the 29th, a solitary Barracoota was caught in a net in the harbour, and next day the fishermen were out for miles off the coast, looking for the expected shoal, but were unsuccessful. On the 31st, they were met with in abundance. A new curing work was started this month in Horseshoe Bay, Stewart Island, to employ about 20 men, two large cutters, and several smaller boats.

November was a month of full and pretty varied supply, the weather mostly fine, with some dull and showery days.

There was some stormy weather during December, but the supply of fish was pretty liberal. A well-boat started to work the reefs off the coast between Waikouaiti and Moeraki, the intention being to bring the fish alive up to the town jetty.

Fish were in full supply during January, save during one or two days of rough weather, which kept the boats from getting out. On the 24th, a fine Snapper was caught, rather larger than the ordinary run of these visitors to our coast. It was 13 lbs. in weight, 29 inches long, by 24 inches in girth. On the 29th, some Tarakihi were brought to market, accompanied by some fine large Trumpeter.

February, except for a few days at the beginning of the month, was a time of full supply, both large and small fish being plentiful. On the 20th, a large Stingaree (*Trigon thalassia*) was caught and brought into town; and on the 22nd a Conger-eel (*Conger vulgaris*), 6 feet 2 inches long, weighing 40 lbs., was on exhibition.

During March there was a fair average supply of all varieties. For some days near the beginning of the month a number of Horse Mackerel were brought to the market. On the 14th a Snapper, and on the 18th a Kahawai was caught.

At the beginning of April fish were abundant, but the supply fell off towards the middle, when severe cold weather prevailed. On the 20th two Frostfish were brought to town, and on the 23rd a big Snapper. An incident of the month was the imposition of a license fee, under the authority of the new Act, of £1 for each net in use.

Fish were in fair supply during May, except during a few days of stormy weather. Some exceptionally large Flounders were caught on the 7th; on the 8th, a fine Snapper; and towards the close of the month Trevally were very plentiful.

June was a month of very severe weather all through, but with the exception of a few days the supply was good and sometimes plentiful. On the 19th, a solitary Barracoota was caught in a net in the Lower Harbour. A market for the sale of fish, etc., was the subject of some discussion during the month.

July was characterised by a continuance of fine clear frosty weather nearly all through the month, winding up with a snowstorm on the last day. The great feature of the month was the abundance of Frostfish which were brought to town in greater or less number for 20 days. They were mostly brought from the beaches between Blueskin and the Heads, and formed quite a small harvest to the younger settlers along that line of the coast, as pretty fair prices were given for them by the dealers, who resold them at prices ranging from five to ten shillings each.

In accordance with the wish of the President and others, expressed at the time I read the paper last year, I wrote to Mr. Traill, of Stewart Island, for particulars as to the state of the trade there, but I never received any reply. However, I am able to give the following statistics as to the number of boats and men engaged in the trade at the present time, August 7th, 1878:—

There are engaged in the fishing, outside of the Heads, 9 whale-boats and 2 cutters, employing about 30 men. In the Harbour or seining branch there are 16 boats and about 40 men engaged. At Port Chalmers there are two smoke-houses with four men to each. At Stewart Island I have learned there are two smoke-houses, and about 30 men engaged in boating, etc.

Hoping that the figures and facts I have drawn together may be of some use to the members, I now bring my three years' task to a conclusion.

Art. LIII.—*The District of Okarito, Westland.* By A. Hamilton.

[Read before the Westland Institute, 16th July, 1878.]

The Okarito district comprises a large area of comparatively unknown ground, as the whole of the settlements which have at one time or another existed on it, have been either on the sea-coast or on the river-beds. The sole attraction to settlers having been the "*Auri sacra fames*," agriculture has been comparatively neglected, though many excellent areas of ground

exist, quite equal to much land in the North Island, that amply repays the capital invested. The opening of the Okarito-Bowen Road will, no doubt, cause more land to be taken up for bonâ fide settlement. Communication will then be of a more certain character, and travellers will be enabled to avoid the difficulties and dangers of the rivers and rocky bluffs on the coast line. One of the most interesting sights in New Zealand, the Franz Josef Glacier, will then attract more visitors to its beautiful scenery and wondrous masses of ice and snow.

In what are generally known as the "early days," Okarito was a flourishing township, and the diggings on the various beaches north and south of it, were swarming with busy workers, washing from the sands the particles of gold brought down by the rivers from the hills ages ago, and since divided into small particles now found. The geology and mineralogy of the hill-country, towards the main range at the back of the district, is not known with accuracy, owing to the difficulties of penetrating the intervening bush. As far as can be judged from the materials composing the terraces which form the undulating ground between the hills and the sea, a number of valuable minerals are stored in this part of the country, and it is not too much to express an opinion that, when fully explored, the ranges south of Mount Tyndall will prove to be the Cornwall of New Zealand. Owing to the deficiency of good harbours on this part of the West Coast, it may be very long before a trade can be established. Hitherto the only mineral sought for has been gold, and many are the places in which it has been found—in fact, it never having been found in the river Waitaki (or Waitangi) renders it a remarkable river, running as it does through the same kind of country, and having rivers and creeks on each side of it that have yielded heavy amounts of gold. I have not the opportunity of examining a return of the total amount of gold procured in the district, but it must be very large, as the different diggings at the Forks, the Three-Mile and Four-Mile Beaches, the Waio and Wateroa rivers and McDonald's Creek, have proved at one time or another very rich. Very few are now working on the beaches, for, though far from being exhausted, the sand shifts so much with every gale of wind and heavy sea, that it mixes the sand from which the gold has been taken with that still containing the metal. Thus to extract the gold requires more labour than previously, as much sand has to be washed that has already been impoverished. Very curious and beautiful this black sand looks under the low powers of a microscope, heaps of rubies and diamonds appear to be mixed with "patines of fine gold" and stones of less brightness and beauty, with here and there thin laminæ of mica and pearly-looking quartz.

Unfortunately for Okarito no reefs have yet been found showing any

signs of gold, though there is plenty of quartz near McDonald Creek, and quartz has been found adhering to gold got at the Forks, and also in the Wateroa. If good reefs were to be discovered they would be of great use in opening up the back country and restoring the now fast-decaying town of Okarito.

Leaving the consideration of the inanimate productions of the district, if we consider the conformation of the country, sloping away from the main range in hills and terraces to the sea-level, we perceive that it is a favourable spot for the occurrence of those forms of animal and vegetable life for which this 'Bird and Fern Land' is noted.

In the sub-alpine, and even alpine regions, are found large numbers of those curious birds, commonly called kiwis and rowis, now the last representatives of that peculiar struthious avi-fauna that once roamed over these islands. Although moa bones have been found in places all over the South Island, their occurrence in Westland is unknown to me. I should be glad to learn if any remains were ever obtained in the neighbourhood of the Haast River, as there seems to be no very great obstacle to their passage from the eastern plains in that direction. Two other birds are peculiar to the alpine regions, the kakapo *(Stringops habroptilus)* and the kea *(Nestor notabilis)*; the former is getting very scarce now, in consequence of its falling an easy victim to dogs and cats that have taken to the bush. In the centre zone or lower hills we find a larger number of perching birds, pigeons and kakas, etc., and also along the river-beds swarms of Maori hens *(Ocydromus australis)*, etc. This impudent and inquisitive bird furnishes a much-prized article of food to diggers and prospectors. A good dog will sometimes catch sixty or seventy in one night. The bodies of the birds are split open and smoked, and will then keep a long time. Their oil is much valued, and is used for as many purposes as Holloway's pills, being an ingredient in many a damper, and an infallible remedy for bruises and rheumatism, besides being used for the general purposes of fat and grease. Attached to this paper will be found a list of all the birds I have seen since I have been here, together with those that are, no doubt, found here, but which are only included from trustworthy report; these have a mark affixed to them.

From this list it appears that the district contains representatives of almost every species of land bird found in the South Island, with few exceptions. Many of the petrels, puffins and other sea birds are doubtless seen off the coast in bad weather, but few come ashore. This district claims, as pre-eminently its noblest bird, the beautiful white heron *(Ardea alba)*, formerly remarkably numerous. I regret to say that since certain miscreants destroyed a quantity of nearly hatched eggs, they have slightly

diminished in number, though many still ornament the upper waters of the lagoon and the river on which they breed, on which river there is also a shaggery (*C. brevirostris* and *carbo*). Another very handsome and remarkable bird, the crested grebe (*Podiceps cristatus*) is tolerably plentiful on the lagoon and smaller lakes. The Okarito Lagoon has been formed from a large bay by the silting up of successive bars of sand and shingle, through which the river and streams flowing into it have had to force their way. Within the past month a succession of heavy southerly winds raised a huge bar of sand and shut up the mouth of the river. The consequence of course was that the water rose till a channel was cut through the bar and the water liberated. It is six or seven miles from the town of Okarito to the head of the lagoon, by a tortuous channel, now winding amongst the mud flats, uncovered at low water, and abounding in pipis and cockles, small crabs and other animals peculiar to brackish water; and now flowing between bushes and shrubs with a channel ten or twelve feet deep, and wide enough to have admitted a steamer, the Woodpecker, I think, once upon a time. Amongst these bush-covered points and islands are quiet nooks in which you may come suddenly upon a flock of black teal (*Fuligula novæ-zealandiæ*), or a party of grey ducks will rise with a great commotion, increased by the harsh scream of the paradise duck (*C. variegata*). I am glad to see that the black swan (*C. atrata*) is now well established in this district; they have increased very rapidly within the last two or three years. I have seen as many as fifty, with a lot of young cygnets, in sight at one time. Some of them occasionally go down south somewhere, in flocks of six or eight, for a few days. Seeking their food on the mud flats at low water may be seen pied redbills (*H. longirostris*), curlews, plovers, dotterels, and the pretty lake gull (*Larus bulleri*). On going inland the silence of the bush is broken by the peculiar notes of the bell-bird (*A. melanura*) and the tui (*Prosthemadera novæ-zealandiæ*), especially where the rata shows its crimson flowers, from extracting the juices of which, with their brush-like tongues, they are often disturbed by the kaka who forsakes the grub-infested log for the honey of the flower. The demand for feather trimmings and kiwi skin muffs has caused the slaughter of a great number of birds in this district and further south. Though the poor kiwis have a slight respite from their former persecutor, there is another on their track with large orders from London houses, and no doubt he will considerably reduce their numbers. I must now apologise for the superficial manner in which I have run over the subjects I have brought before your notice, and I trust when my collections are more complete, that I shall be able to present to the Society a list of the plants, etc., found in the neighbourhood, and to supplement this paper with further particulars of other objects of interest.

Since the above was written I paid a visit to the well-known heronry on the Waitaki-tuna, and I regret to say that the birds have abandoned the spot in which they formerly bred. In 1876 six broods were reared, and the nests, as well as remains of numerous old ones, still remain. There can be no doubt that the way in which the saplings were torn down to procure the eggs was the cause of the disruption of the colony. The small shag (*G. brevirostris*) has also disappeared simultaneously. It is to be hoped that the white herons will find a more secure place for their new home, and thus arrest for a few years their extinction.

List of Birds found in Okarito District.

I. Accipitres.

Falconidæ. *Hieracidea novæ-zealandiæ*, Lath. *Circus gouldi*, Bp.
Strigidæ. *Athene novæ-zealandiæ*, Gml.

II. Psittaci.

Stringopidæ. *Stringops habroptilus*, Gray.
Platycercidæ. *Platycercus novæ-zealandiæ*, Sparrm. *P. auriceps*.
Trichoglossidæ. *Nestor meridionalis*, Gml. *N. occidentalis*, Buller. *N. notabilis*, Gould.

III. Picariæ.

Alcedinidæ. *Halcyon sanctus*, Vig. et Horsf.
Cuculidæ. *Chrysococcyx lucidus*, Gml. *Eudynamis taitensis*, Sparrm.

IV. Passeres.

Menuridæ. *Orthonyx ochrocephala*, Gml. *Certhiparus novæ-zealandiæ*, Gml.
Meliphagidæ. *Zosterops lateralis*, Lath. *Prosthemadera novæ-zealandiæ*, Gray. *Anthornis melanura*, Sparrm.
Muscicapidæ. *Rhipidura flabellifera*, Gml. *R. tristis*, Homb. et Jacq.
Turdidæ. *Keropia crassirostris*, Gml.
Sylviadæ. *Gerygone flaviventris*, Gray. *Petroica macrocephala*, Gml.
Motacillidæ. *Anthus novæ-zealandiæ*, Gml.
Certhiidæ. *Acanthisitta chloris*, Sparrm.
Maluridæ. *Sphenœacus punctatus*, Quoy et G.
Sturnidæ. *Creadion carunculatus*, Gml.
Corvidæ. *Glaucopis cinerea*, Gml.

V. Columbæ.

Columbidæ. *Carpophaga novæ-zealandiæ*, Gml.

VI. Gallinæ.

Tetranoidæ. *Coturnix novæ-zealandiæ*, Q. et G.*

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* I have not obtained these.

VII. GRALLÆ.

Rallidæ. *Ocydromus australis*, Sparrm. *O. fuscus*, Dubus.* *Rallus pectoralis*,* Less. *Ortygometra affinis*,* Gray. *O. tabuensis*, Gml. *Porphyrio melanotus*, Temm.

Scolopacidæ. *Limosa uropygialis*, Gould.

Charadriidæ. *Charadrius obscurus*, Gml. *C. bicinctus*, Jard. *Thinornis novæ-zealandiæ. Hæmatopus longirostris*, Vieill.

Ardeidæ. *Ardea alba*, L. *Ardea pusilla*, V. *Ardea poiciloptera*, Wagl. *Nycticorax caledonicus*, Lath.*

VIII. ANSERES.

Anatidæ. *Casarca variegata*, Gml. *Querquedula gibberifrons*, S. Müller. *Rhynchaspis variegata*, Gould. *Fuligula novæ-zealandiæ*, Gml. *Hymenolaimus malacorhynchus*, Gml.

Laridæ. *Larus dominicanus*, Licht. *L. scopulinus*, Forst.* *L. bulleri*, Hutton. *Sterna caspia*, Pall. *S. frontalis*, Gray. *S. antarctica*, Forst.

Pelecanidæ. *Graculus carbo*, L. *G. brevirostris*, Gould.

Ptilopteri. *Eudyptes pachyrhynchus*, Gray.

Podicepidæ. *Podiceps cristatus*, L. *P. rufipectus*, Gray.

IX. STRUTHIONES.

Apterygidæ. *Apteryx australis*, Shaw. *A. oweni*, Gould. *A. maxima*, Verr.

ART. LIV.—*Notes on the Breeding Habits of the Katipo* (Latrodectus katipo).

By C. H. ROBSON.

[*Read before the Wellington Philosophical Society, 3rd August*, 1878.]

THE Katipo is found in great abundance all along the coast of the South Island, from the mouth of the Wairau river to the Kaikoura peninsula. They are all of the variety so well described by Dr. Buller and Dr. Powell, in Vol. III. Trans. N.Z. Inst., pages 34 and 56, and all have the bright scarlet band with yellow border on the abdomen; the other markings are distinct on some individuals and faint on others. The black variety without a red dorsal stripe, and which is mentioned by the Rev. M. Taylor and Mr. Wright does not seem to inhabit this part of the coast, nor have I ever seen it. The above writers having made no mention of the number of young which these spiders produce from a single cocoon, or the time occupied in doing so, I determined to try and settle these points by actual experiment, with the following results:—On November 4, 1877, I put a

* I have not obtained these.

female katipo in an empty, clear glass bottle; she at once began to make a fine irregular web, and, on the morning of the 8th, I found that during the night she had constructed and suspended near the neck of the bottle, a spherical cocoon, composed of a pale yellow silky web, through which one could see the purplish eggs; for the next two months the spider remained on or close to the cocoon; I put several flies and other insects into the bottle, all of which she at once killed and threw down to the bottom without eating. Early in January she shifted the cocoon close to one side of the bottle at the shoulder, and took up a position for herself three-quarters of the distance from it to the bottom of the bottle. By this time she was reduced to half the original size and was very inert, and, on the 7th February, 1878, sixty young katipos issued from the cocoon. Next morning the mother lay dead at the bottom of the bottle; it must not be supposed that the old spider always dies in this way, for I had one which ate the greater part of her family before doing so. The young ones are of a semi-transparent white, with two lines of black dots on the abdomen, and black joints to the legs, the underside of the abdomen being brown, with an irregular whitish centre.

Art LV.—*On Additions to the Carcinological Fauna of New Zealand.*

By T. W. Kirk, Assistant, Colonial Museum.

[*Read before the Wellington Philosophical Society, 31st August,* 1878.]

The publication of a 'Catalogue of New Zealand Crustacea' by the Geological Survey and Colonial Museum Department, has proved a great boon to students and collectors in the colony, by bringing together, in a convenient form, descriptions of all the species known to inhabit these shores, thus enabling them to pronounce, with some degree of certainty, upon any specimen which may be under discussion.

The remarkable resemblance which our fauna bears to that of England and California has been pointed out by many authors. I have now to record the occurrence here of at least two additional European and the same number of Californian species.

Three of the species mentioned in this paper, viz., *Caprella lobata*, *C. novæ-zealandiæ*, and *Ebalia tumefacta*, were obtained in Cook Strait, in January, 1876, whilst dredging for the telegraphic cable.

Group Aberrantia.

The coxæ of the pereiopoda are not squamiformly developed, some or all being fused to their respective segments. The pleon has one or more of the segments absent.

Fam. 2, Caprellidæ.

Pleon rudimentary: oral appendages normally developed; coxæ fused with the pereion; branchial sacs attached to the first two or three segments of the pereion.

Caprella.

Caprella, Lamarck, Syst. des anim. sans vert., p. 165.
Leach, Linn. Trans. II., p. 363.
Edwards, Hist. des Crust. III., p. 105.
Kröyer, Nat. Tidskr. IV., p. 496, 1842-3.
Ægina, Kröyer, Nat. Tidskr. IV., 1843.
Podalirius, Kröyer, Nat. Tidskr. V., 1844.

Body cylindrical; cephalon and first segments of pereion confluent; pleon rudimentary; gnathopoda sub-chelate; first two pairs of pereiopoda represented by the branchiæ attached to their respective segments only; three posterior pairs of pereiopoda subequal; first and second pairs of pleopoda rudimentary in the male; the rest obsolete. (Spence Bate, Cat. Amphip. Crust. Brit. Mus., p. 353.)

Caprella novæ-zealandiæ, sp. nov.

Cephalon furnished with a spinous tooth directed forwards; first segment of the pereion rather short, second long, third and following gradually decreasing; superior antennæ two-fifths the length of animal; flagellum with the infero-distal extremity of each articulus produced, but *without* cilia; inferior antennæ not so long as the peduncle of the superior by one joint; second pair of gnathopoda articulating behind the centre of second segment of pereion; propodos ovate; palm armed with a prominent posterior tooth, against which the closed dactylos impinges, and a smaller but distinct anterior tooth (not lobe); dactylos very much curved; three posterior pairs of pereiopoda have the anterior margins excavate and ciliate; the parts against which the closed dactylos impinges, armed with a strong tooth.

Length 1 in.

Hab: Cook Strait.

This species approaches *C. geometrica*, Say, (Cat. Amphip. Crust. Brit. Mus., p. 357), from which it differs, however, in the form of the spine on the cephalon, in the length of the antennæ, and in the articulation and arming of the second pair of gnathopoda.

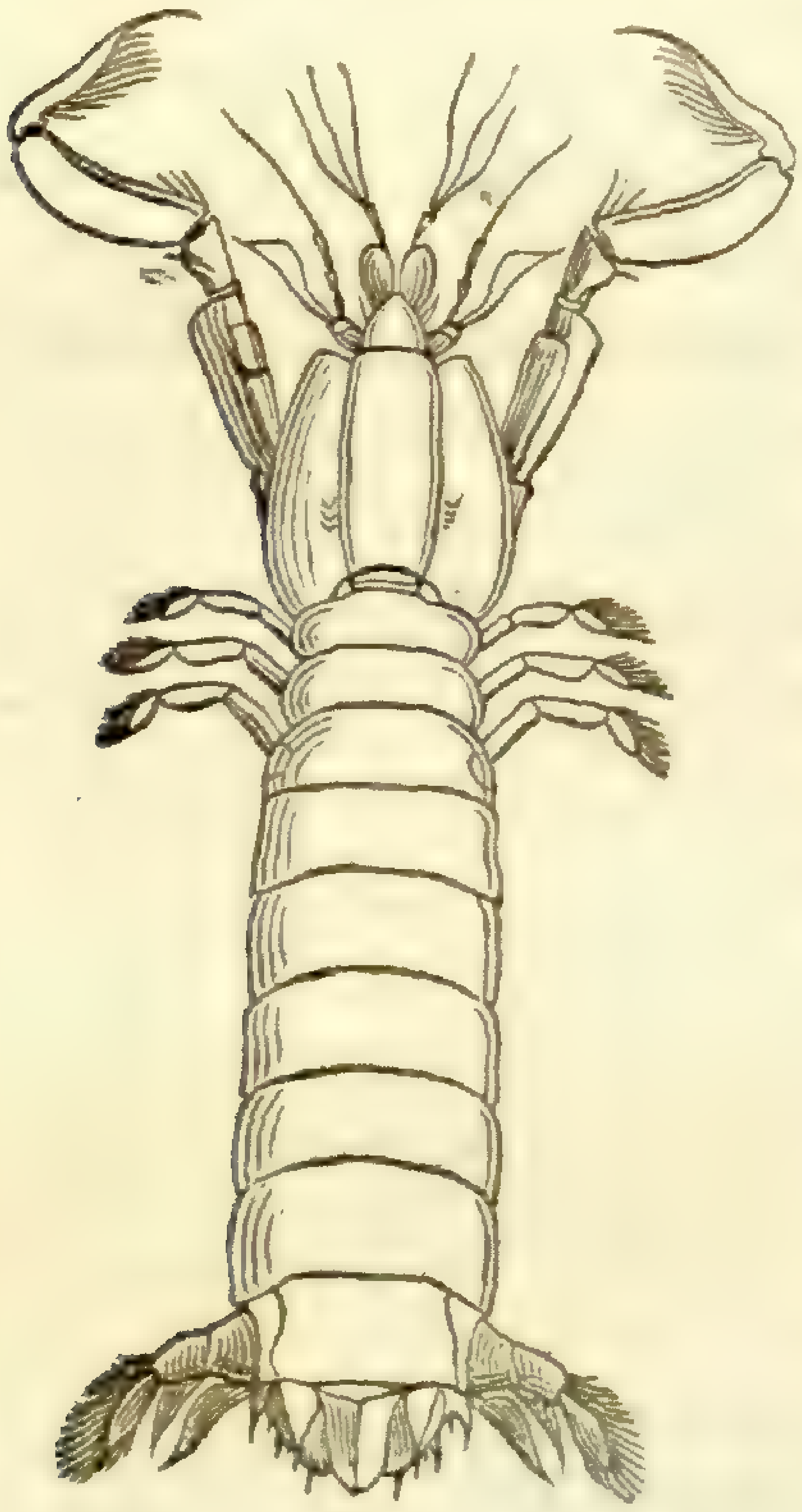
Caprella lobata, Guérin.

Squilla lobata, Müller, O. Fabr. Faun. Grönl., p. 248.
Caprella lobata, Guérin, Iconogr. Crust., pl. 28, f. 22.
" " Kröyer, Voy. en Scand., pl. 25, f. 3.
" " Stimpson, Nat. Hist. Invert. Grand Manan., p. 44.
Ægina longicornis, Kröyer, Voy. en Scand., pl. 26, f. 3.
Caprella lævis, Goodsir, Edinb. New Phil. Journ., XXXIII.
" " White, Hist. Brit. Crust., p. 215.
Caprella linearis, Leach, Edinb. Encycl., p. 404.

Body carrying a few minute tubercles, the most conspicuous being the one on the cephalon, and the most constant those upon the posterior segments of the pereion. First segment of the pereion long; second scarcely longer than the first; the three succeeding rather shorter, sub-equal. Superior antennæ not half the length of the animal; inferior scarcely reaching beyond the second joint of the peduncle of the superior. Second pair of gnathopoda articulating with the pereion posteriorly to the centre of the second segment; propodos long-ovate, palm defined by one and armed with two teeth, the anterior one being often less perfectly defined than the posterior. Three posterior pairs of pereiopoda having the propoda with the anterior margin excavate; the part against which the closed dactylos impinges armed with two stiff corrugated spines.

Hab: Cook Strait.

The only examples of the genus *Squilla* yet recorded from New Zealand are *S. nepa*, Cat. N.Z. Crust., p. 89, and *S. armata*, M. Edw., Trans. N.Z. Inst., IX., p. 474. It is with very great pleasure I now add a third. In addition to the specimen exhibited, which was obtained at the Chatham Islands, another, unfortunately mutilated, was secured by H. B. Kirk while on a visit to Kapiti.



Squilla indefensa, sp. nov.

Rostral plate semi-oval, and pointed at its distal extremity. Carapace retracted in front, expanded and rounded behind, smooth, the antero-lateral angles rounded and slightly produced forward; large prehensile limbs with terminal joint as long as preceding one, and armed with *nine* spines; abdomen smooth, terminal segment with six marginal spines, and three depressed longitudinal ridges which terminate posteriorly in spines.

Length, $2\frac{1}{2}$ inches.

Hab: Chatham Islands and Kapiti.

This species is easily distinguished by the absence of carinæ on the abdomen, and by the absence of the antero-lateral spines of the carapace.

Ebalia.

Ebalia, Leach, Zool. Misc. III.

External antennæ extremely minute, inserted in the inner canthus of the orbit; internal antennæ lying in oblique fossæ, which are entirely separated by a small process of the epistome, and concealed by the front; external pedipalps elongato-triangular, reaching forward to the margin of

the epistome; the internal footstalk gradually acuminated, the third joint internally palpigerous; anterior legs large, equal, the hand inflated, those of the male larger than those of the female; the other legs shorter than the first pair, diminishing gradually in length, terminating in a slightly curved, rather strong claw; abdomen seven-jointed, but with several of the middle joints confluent; that of the male narrow; of the female very broad, the last joint very small, abruptly narrower than the preceding; carapace rhomboidal, with the angles more or less truncated or rounded; front produced, elevated; eyes very small; orbits with two small fissures on the superior margin.

Ebalia tumefacta. Bryer's Nut Crab.

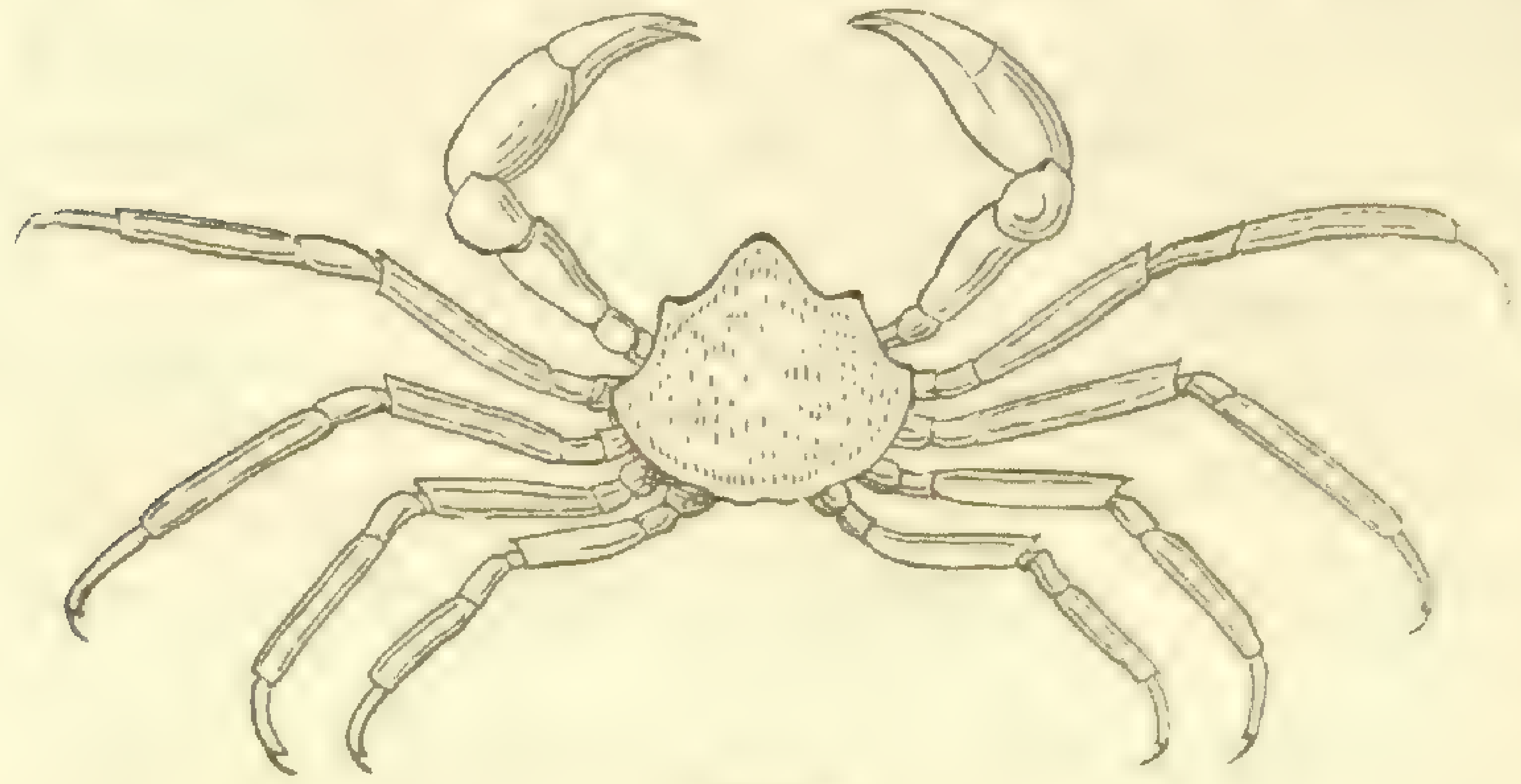
Cancer tumefacta, Mont., Trans. Linn. Soc. IX., p. 86, T. II., f. 3.

Ebalia bryerii, Leach, Mal. Podoph. Brit., T. XXV., f 12-13.

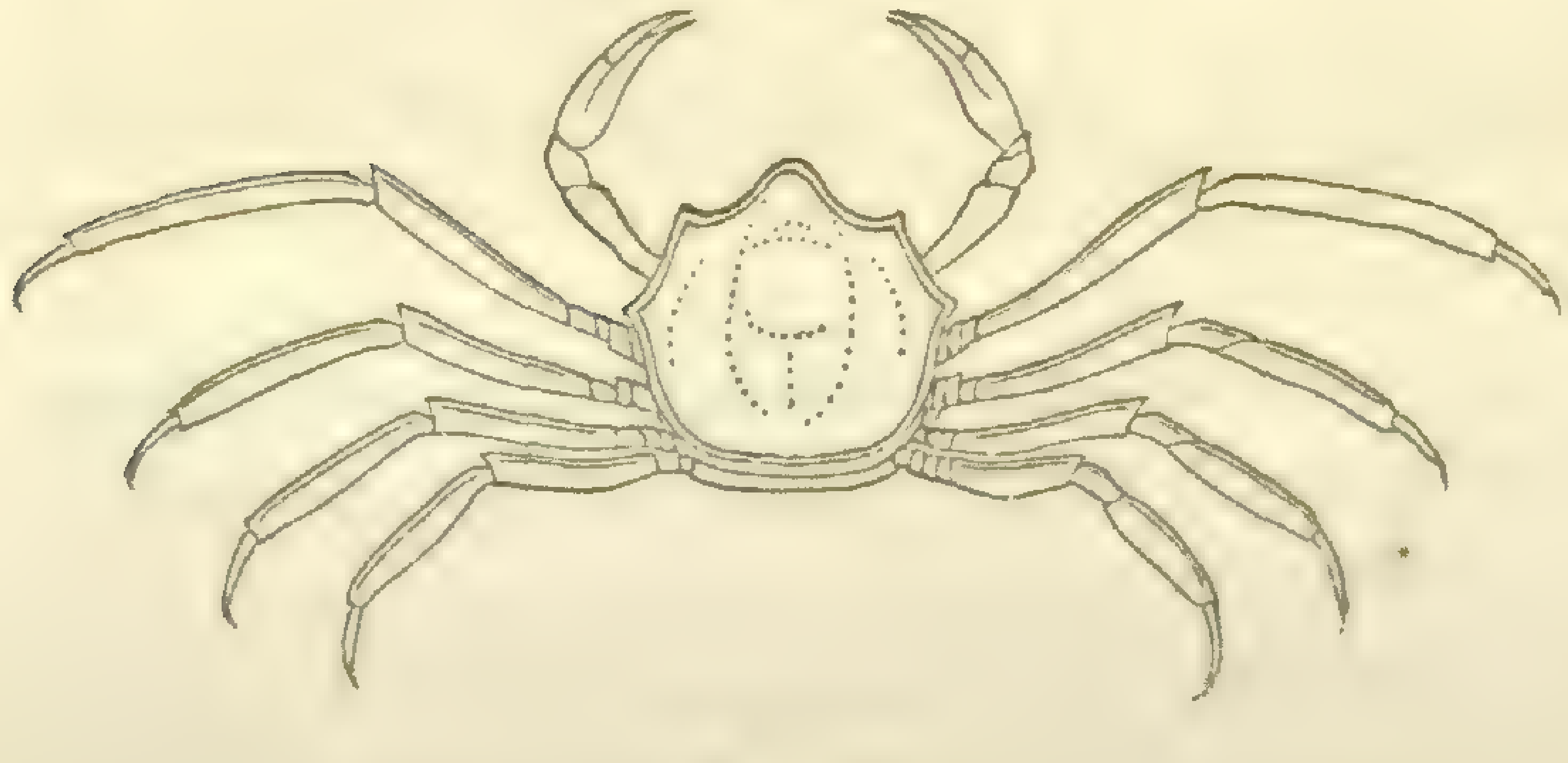
Carapace slightly and minutely granulated; lateral margin entire, somewhat revolute at the angles; two tubercles on the cardiac region, and one on each of the branchial in the male; these parts very tumid in the female; abdomen in the male with the third to the fifth joints united; in the female the fourth to the sixth; arm not more than twice as long as it is broad. (Bell's Brit. Crust., p. 145.)

Hab: Cook Strait. A single female, and the right anterior leg of another specimen.

Elamena producta, sp. nov. New Zealand Spider crab.



Male.



Female.

Carapace flat, broader than long, margin with two teeth, which, however, vary much in size; rostrum very prominent; anterior legs in male large and equal, hand and wrist much swollen; fingers curved and armed with hairs along their inner margins; in the female these legs are slight, and the fingers almost straight; succeeding legs very flat, the anterior margin

of the first joint produced so as to form a very prominent point, almost a spine; claws half the length of preceding joint; whole animal destitute of hair, except on the fingers. Length, $\frac{5}{8}$ in.; breadth, $\frac{4}{8}$ in. First three pairs of ambulatory legs very long, more than twice the length of the carapace.

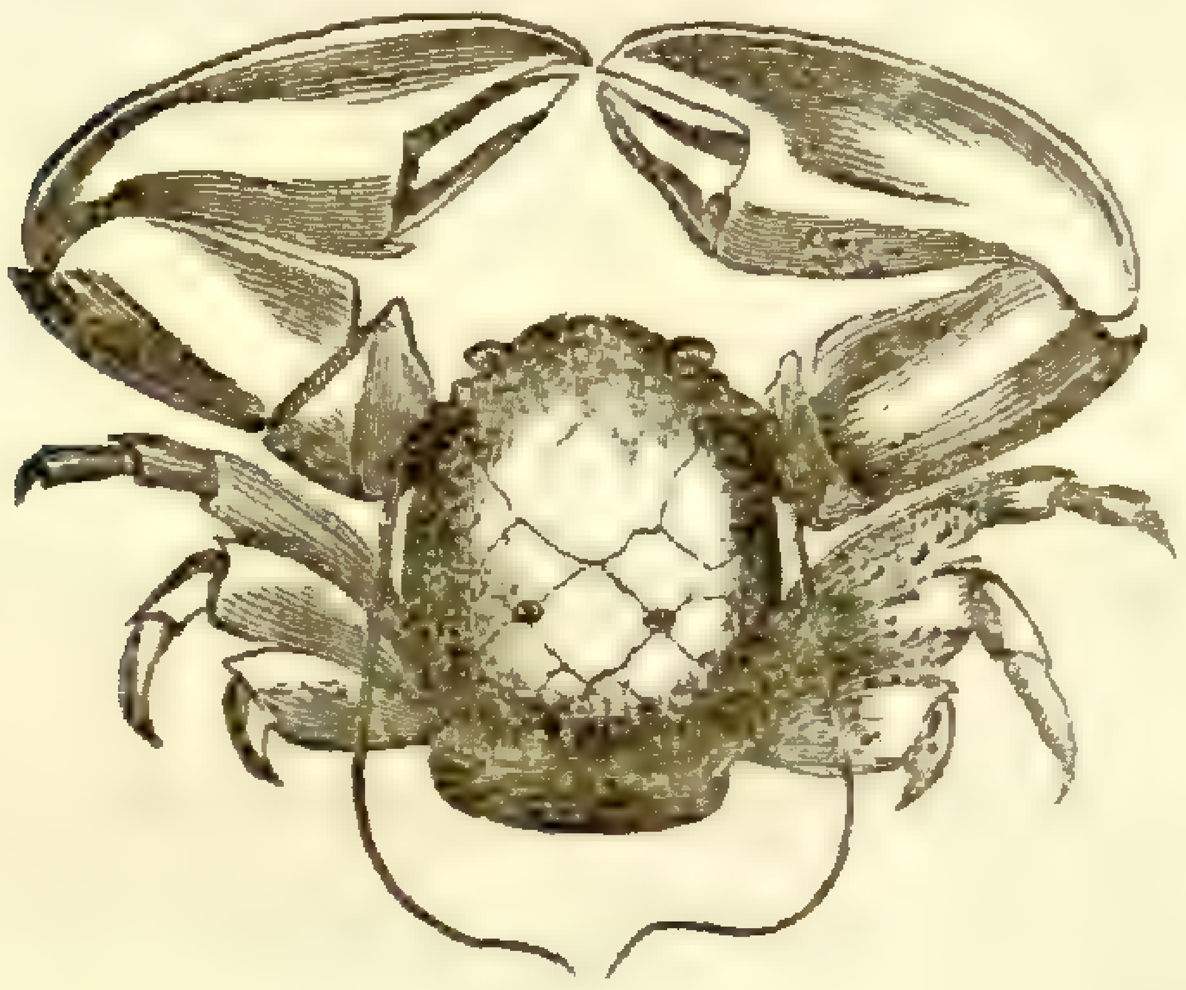
Hab: Wellington.

Petrolisthes elongatus, Miers.

In the 'Catalogue of New Zealand Crustacea,' p. 60, this species is said to be of a "reddish-yellow" colour. The specimens from which the description was drawn up must have been preserved in spirit. This change of colour is usual in specimens so treated. The following is taken from living examples.

Above dark blue, greenish-blue, or sometimes even black. Below green, getting much darker towards the posterior margin of the anterior legs, anterior face of wrist a bright red, mobile finger and antennæ deep brown.

Porcellana rupicola, Stimpson.



A single specimen of this species was recently obtained by myself at Lyall Bay, living apparently upon terms of intimacy with a large family of *Petrolisthes elongatus.* Upon a comparison with the foreign Crustacea in the Colonial Museum, I find it to agree in every particular with a specimen contained in the collection lately received from Prof. Button of the University of California, and labelled as above.

Unfortunately I have not been able to obtain the description either of this or the next species, but there can be no doubt respecting their identity, as those forwarded by Prof. Button are duplicates of the U.S. Exploring Expedition's collection.

This species may be easily distinguished from *Petrolisthes elongatus* by its having the posterior margin of the wrist produced, so as to form one strong tooth, by its more drooping front, and by having the lateral margins obtuse instead of thin and sharp. Length, $\frac{5}{8}$ in.; breadth, $\frac{4}{8}$ in.

Xantho spino-tuberculata, Lockington.

A fine pair of this beautiful little crab was procured at Porirua Harbour, in January of last year, and although only about half the size of the Californian specimen, there can be no mistaking their identity.

The carapace is much broader than long, the front armed with spinous tubercles; regions well defined; anterior legs strong, equal, the outer and

upper surfaces covered with very prominent tubercles; fingers brown, tipped with white, smooth, except their internal margins, which are armed with 3 or 4 tubercles. Ambulatory legs densely covered with hairs.

Male, length $\frac{6}{16}$ in., breadth $\frac{9}{16}$ in.

Female, length $\frac{5}{16}$ in., breadth $\frac{8}{16}$ in.

Art. LVI.—*On some New Zealand* Aphroditæ, *with Descriptions of supposed new Species.* By T. W. Kirk, Assistant in the Colonial Museum.

[Read before the Wellington Philosophical Society, 30th October, 1878.]

Aphrodita.

Halithea, Savigny, Syst. Annel. 11 and 18. Lam., An. s. Vert., v. 306.

Aphrodita, Leach, in Suppl. Encyclop. Brit. I., 452; Aud. and M. Edw., Litt. de la France, II., 63; Blainville in Dict. des Sc. Nat. LVII., 455; Fleming in Encyclop. Brit., Edit. 7, XI., 221; Johnston in Ann. Nat. Hist. II., 427.

Body ovate or oblong, the back convex, covered with fifteen pairs of scales, either concealed by a felt or exposed; the venter distinctly separate, flat, marked with the dissepiments and a longitudinal mesial furrow; antenna one, mesial, small; the palpi two and long; segments 39, with scales on the second, fourth, fifth, seventh, and every alternate segment to the twenty-fifth, and on the twenty-eighth and thirty-second; the intervening segments with a dorsal cirrus; feet stout, biramous, with three fascicles of bristles, two on the dorsal and one on the ventral branch; and each foot has a ventral setaceous cirrus; bristles various, simple or compound, with a spine in each fascicle; no anal styles.

A. aculeata.

Aphrodita aculeata, Linn. Sys. X., 655; XII., 1084.

Body from 3 to 8 inches long, oval, narrowest behind, convex dorsally; the back of an earthy colour; roughish, with a thick close coat of hair and membrane, forming a sort of skin, which entirely conceals the scales; the sides clothed with long silky green and golden hairs clustered in fascicles, and glistening like burnished metal, with blackish-brown spiniform bristles intermixed; ventral surface flat, often light coloured and dotted, sometimes dark brown, obsoletely ribbed across; head small, entirely concealed, roundish, with two round clear spots or eyes on the vertex; antenna minute; palpi large, subulate, flesh-coloured or dusky, jointed at the base, where they approximate, but are separated by a black membranous crest; mouth with a large edentulous proboscis; the orifice encircled with a short, even, thick-set fringe of compound penicillate filaments divided into two

sets by a fissure on each side; each filament has a short stalk, with a tuft of numerous forked papillæ on its summit; exterior to the orifice of the proboscis there are four fleshy tubercles placed at the angles; scales fifteen pairs, roundish, smooth, thin and vesicular, blotched with black stains and specks, the first pair small, laid over the head, the anal pair oval; feet thirty-nine pairs, largest and most developed near the middle of the belly, very small and approximate at the anus, biramous, the branches wide asunder; the superior carries, in a sort of crest-like fashion, the long, flexible, brilliant-coloured bristles which form the silky fringe on each side of the body, and above them some still more delicate hairs, which, by their intertexture, constitute the membrane covering the scales, and with which the strong spiniform bristles are intermixed, placed in a sort of cross series; the inferior branch is armed with three rows of stout, short bristles; in the upper row only two or three, which are longer and stouter than those of the next row, in which there are five or six, and which again are stouter but less numerous than those in the lower row; spine golden-yellow, conical, smooth; superior cirrus long, subulate, bulged at the base; the inferior short and conical; anus large, with a dorsal aspect, encircled with several tentacular cirri.

"The very vivid iridescent hues, which the hairs of this remarkable worm reflect, render it an object of wonder and surprise to the most incurious; they are not equalled by the colours of the most gaudy butterfly, and rival the splendour of the diamond beetle. It creeps at a slow pace, and in its progress a current of water is ejected at short intervals, and with considerable force, from the anus. When placed in fresh water, the creature gives immediate signs of its painful situation, and soon dies, first ejecting a white milky fluid, and in the agony of death, a large quantity of blackish-green turbid liquor. The size and strength of the proboscis is remarkable, and not less so the structure of the filaments which garnish the orifice. The œsophagus is short; the stomach and intestine seem to be alike and inseparable; together they form a straight intestine, sometimes with a wide dilation in some part of its canal, with a velvety inner surface folded into longitudinal plaits near the termination at the anus." (Cat. Worms, B.M., p. 104.)

I have quoted Dr. Johnston's descriptions and remarks at some length in the hope that the attention of local collectors being called to this branch of our fauna, we shall soon possess better specimens of this very interesting group than are at present to hand.

Unfortunately our specimen, which is very young, does not show the brilliant iridescent colours mentioned above; it is of a uniform dull brown, but after a very careful examination and comparison with two specimens

from Europe contained in the collection of Annelids in the Colonial Museum, I have not the slightest hesitation in referring it to this species; it was obtained, together with specimens of the following species, amongst a mass of tangled seaweed, thrown up in August last, at Worser Bay.

Lepidonotus.

Lepidonotus, Leach in Ann. Phil. XIV., 205 (1819), and in Supp. Encyclop. Brit. I., 452.

Lepidonote, Oersted, Annul. Dan. Consp. 12; Annul. Dorsibr. 11.

Polynoë, Savigny, Syst. Annel. 20. Lam. An. s. Vert., V. 308, Aud. and M-Edw. Litt. de la France, II., 74. Cuv. Régn. Anim., III., 207. Johnston in Ann. Nat. Hist., II., 428 and 431. Williams, Rep. Brit. Assoc. 1851, 217.

Eumolphe, Blainville in Dict. des Sc. Nat., LVII., 457.

Body oblong, flattened, obtuse and rounded at both ends, composed of a definite number of segments, the back covered with two rows of scales; head distinct with two pairs of eyes on the sinciput; proboscis fringed with simple tentacles at the orifice, and furnished with two jaws; antennæ 3; palpi 2; tentacular 2 on each side; these are similar in structure, and jointed only at the base; scales naked, 12 placed over every alternate segment, so that the 12th is on the 23rd; if there are more scales, the succeeding are on every third segment; feet well developed, biramous, but the branches are almost connate, furnished with two fascicles of bristles, the superior in a spreading tuft, the inferior in a flattish brush, a spine on each fascicle; bristles simple, stout, the superior tapered to a serrulate point; the inferior with a claw-like point, and flattened underneath on one side of the shaft, where it is roughened with spinous tentacles in claw-set transverse series; anal segment with styles.

"*Lepidonotus* is easily distinguished from *Aphrodita* by the number of the antennæ, by the more powerful armature of the mouth, and by the part of the body at which the scales cease to alternate with the cirri. The back is either entirely covered with scales, or naked in the middle, the scales in the latter case being less developed, and not meeting on the mesial line."

"The *Lepidonoti* are carnivorous. They prey on living invertebrates, and the strong do not hesitate to kill the weak of their own and allied species; they live in obscurity on rocky shores, and can move with considerable quickness. Some of them swim easily in a wriggling manner, but they hasten to find the bottom. They have the power of renewing the scales, which are frequently removed by abrasion and injury."

Lepidonotus squamatus.

Aphrodita squamata, Linn. Syst. X. 655; XII. 1084.

Lepidonotus squamatus, Johnston, Cat. Worms B.M., p. 109.

"Body generally about one, rarely two inches long, depressed, linear-oblong, of equal breadth at both ends, of a uniform cinereous colour, rough; scales twelve on each side, rather large, ovate, imbricate, rough with brown

granulations, ciliated on the external margin, the overlapped smoother than the exposed portion, for the granules on the former are more minute than on the latter; the anterior scales are smaller and rounder than the others, and completely cover the head, which is a sub-triangular pink or purplish corneous plate, furnished with four small eyes; antennæ three, the central one largest, bulbous near the point; palpi two, longer than the antennæ, swollen near the apex; the tentacular cirri similar to the superior cirri of the feet, these are white, with a blackish ring at the bulb where the acumination commences, retractile, originating from above the dorsal branch of every alternate foot, and under the scales; the last three pairs of feet each with a cirrus; feet twenty-five pairs, obtuse, sub-bifid, the dorsal branch shorter and less than the ventral, each terminated with a brush of stiff brown bristles, and under the ventral branch there is a small setaceous cirrus, and also a fleshy spine at its junction with the belly; bristles when removed golden-yellow, those of the dorsal branch slenderest, gently curved, pointed, and serrulate for about half their length, those of the ventral branch stouter, slightly bent near the top, and serrulated with a double series of teeth on the outer side of the bend, each tuft of bristles enclosing a dark brown straight spine, the inferior stouter than the upper one; ventral surface straw colour, prismatic, marked with the viscera, and sometimes spotted with black near the base of the feet." (Cat. Worms, B.M., p. 107.)

Two very fine specimens of this species were obtained at Worser Bay in August last.

Lepidonotus giganteus, sp. nov.

Body elliptical, rather broader posteriorly than in the front; convex dorsally, of a brown colour, tinged with slate; scales ovate, imbricate, coarsely granulate, projecting beyond the sides of the body, towards the posterior and lateral margins of each scale the granulations assume the character of short stout spines, external margins ciliated, the overlapped smoother than the exposed portion; anterior scales smaller than the others, sub-circular, very coarsely granulous, completely covering and projecting beyond the head; twenty-five pairs of feet, sub-bifid, the dorsal branch much the smaller, and carrying a bunch of *silky hairs*, while the ventral is armed with a bundle of *coarse bristles* of a deep golden colour. Under the ventral branch is a fleshy cirrus. A very obtuse fleshy spine marks the junction of each foot with the belly; ventral surface a pale yellowish white.

Length, 4 inches; breadth, $1\frac{4}{10}$ inches.

Hab: Wellington.

Art. LVII.—*Notes on some New Zealand Crustaceans.* By T. W. Kirk, Assistant in the Colonial Museum.

[*Read before the Wellington Philosophical Society, 11th January,* 1879.]

Squilla, Fabr.

Squilla armata, M. Edw., Hist. Nat. Crust., II., p. 521; Gray, Hist. Chile, Zool., Vol. III., Crust., p. 223; Trans. N.Z. Inst., Vol. X., p. 474.

Several very fine specimens of this species were recently obtained in Wellington Harbour.

At the same time a specimen was procured differing from *S. armata* in having a high median crest on the carapace; no spines on the ophthalmic segment; only five spines on the terminal joint of the prehensile limbs, and a nearly square rostral plate.

The specimen is much broken, the whole of the thoracic segments are missing. Length about 5 inches.

Squilla indefensa, Mihi.

A third specimen of this species was shown to me a short time since; it was procured at Waikanae by Mr. J. Taylor, a student of the Wellington College, and is now preserved in the Museum of that institution.

Calocaris, Bell.

Calocaris macandreæ, Bell; Brit. Crust., p. 231.

Two specimens of this remarkable Crustacean were obtained by myself a few weeks since, on the Otaki beach, near the wreck of the 'City of Auckland.' Although they must have been lying on the sand for some hours at least, one of them showed distinctly the delicate pink colouring mentioned by Prof. Bell in his description.

Callianassa, Leach.

Callianassa. sp. ind.

A specimen undoubtedly referable to this genus has been obtained by Mr. H. B. Kirk, at Island Bay. The carapace is much broken; right claw the largest. Total length, 1⅝ inch.

Gebia, Leach.

Gebia hirtifrons, Dana; U.S. Explor. Exped., XIII., Crust., part I., p. 511.

A specimen in the private collection of Mr. H. B. Kirk appears to belong to this species. It measures 2½ inches in total length, "the hand slender, hairy, and not denticulated below; the wrist has a spine at its upper apex and one on the inner margin, but none at the lower apex;" legs hairy; "front hardly, if at all, three-lobed."

The specimen agrees well with the figure of *G. hirtifrons*, in the Zoology of the Voyage of H.M.SS. 'Erebus' and 'Terror.'

There are also in the collection specimens agreeing well with the description of *G. danai*, Miers.

Portunus, Leach.

Portunus pusillus, Leach, Malac. Brit., t. IX., f. 5–8; Edwards, Nat. Hist. Crust., I., p. 444; Bell, Brit. Crust., p. 112.

Three specimens agreeing well with Prof. Bell's description are in the Colonial Museum; the only difference being that the New Zealand specimens have a prominent spine on the anterior margin of hand.

Female, length, $\frac{5}{10}$ inch; breadth, $\frac{6}{10}$ inch. Male, length, $\frac{4}{10}$ inch; breadth, $\frac{5}{10}$ inch.

Hab.: Cook Strait.

Podocerus, Leach.

Podocerus cylindricus, Say, Jour. Acad. Philad., I., part 2; Edwards, Hist. des Crust., III., p. 64; Cat. Amp. Crust. B.M., p. 256.

Three specimens were obtained at Worser Bay, in tangled seaweed.

Pleustes, Spence Bate.

Pleustes panoplus, Kroyer, Grön. Amf., p. 42, pl. 2, f. 9; Edwards, Hist. des Crust., t. III., p. 41: Cat. Amp. Crust. B.M., p. 63.

Seven specimens at same time and place as last species.

These are both arctic species, and their occurrence on our coast is somewhat remarkable.

III.—BOTANY.

Art. LVIII.—*Further Observations upon certain Grasses and Fodder Plants.* By S. M. Curl, M.D.

[*Read before the Wellington Philosophical Society, 17th August,* 1878.]

In addition to those grasses and fodder plants I had the honour to recommend, in papers read before the Wellington Philosophical Society, in the years of 1876 and 1877,* there are others which I have tested, and which I would now desire to bring before this scientific society.

All who have experimented in the introduction, culture, and growth of plants in New Zealand, will have been struck with the wonderful way in which plants from very different climates seem to acclimatise themselves and do well in this country; and when looking through my notes upon the growth of hundreds of genera and species of grasses under test culture, it is interesting to find how many there are that have done not only more than was expected of them, but that have proved themselves fully worthy of being introduced here into the systems of farming and grazing in the several localities of this colony.

The moderate range of temperature between the extreme heat of summer and the worst of our cold weather in winter, with the frequent occurring rains, seem to enable those plants that can be generally raised from seed to accustom themselves to this country, although they may be indigenous to very different climates.

And as grasses and many fodder plants may be frequently removed from seed sown, the succeeding are more acclimatised than the preceding generation, so that in a few years a race of plants are produced that have become accustomed to the climate, and whilst possessing their several characteristics have become hardy here, and have developed qualities that are not found in other species, and these various differences make them valuable to those requiring such particulars in the plants they cultivate.

In growing grasses and fodder plants, not only is the constant succession of growth in the diverse species a matter of much importance, as growing greater quantities of herbage, but as each species takes up and

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* Trans. N.Z. Inst. IX., p. 531; and X., p. 345.

changes into its tissues, structures or parts, elements different from the others, the animals fed thereon will not only eat the fresh food with greater avidity, but they will digest and assimilate it better than if fed upon one kind alone, and some will grow, thrive, and fatten quicker upon it. And further, from the peculiar habits of growth, and their root and leaf action, the different species of grasses will, either in mixed pastures or alone, extract from the soil, the water, and the air, exactly such qualities and quantities of the elements as will build up their own tissues and products, and which they alone will be able to present in that peculiar form to the animals fed thereon; thus, from the very same fields and farms, the many different varieties, species, and genera of grasses, will not only grow and give larger quantity than one kind alone, but will present to the animals fed on this field or farm, a far larger number and amount of chemical elements than can any one or two species, and it does not require a very profound knowledge of physiology and dietetics to understand that varieties of food are very beneficial, for though to men and women a beef steak, or a vension haunch, may be very delightful occasionally, yet if they had only these all their lives for every meal, they would have to be starved into eating them; and precisely so with our sheep and cattle eating rye-grass and clover all their lives, yet they would thrive much better, and pay their owners more quickly, if fed on forty or fifty different species of grass and fodder plants. It is well known that the cheese made in certain parts of the world, cannot be made elsewhere, and this is because the animal cannot obtain the same food and assimilate its elements in other places. For while botanists have found over forty kinds of plants in the fields of Leicestershire, Gloucestershire, Huntingdonshire, and Cheshire, besides other places, and upon any of them the pedigree sheep and cattle can feed at their pleasure, it is hardly likely that they will thrive and pay as well when forced to live on two or three kinds. And while in the several parts of the earth, whether upon the Swiss mountains, the Dutch water meadows, the wild pastures of the Cape, America, or Australia, the animals fed there develope certain qualities and excellences, without you can provide them with the same grasses and fodders they will not do the same elsewhere. But in this favourable land of ours here we can, if we will, make these plants grow and thrive upon our fields and pastures, and our sheep and cattle will benefit by these introductions and being fed thereon. Now that population is pouring into this Colony, and the land will have to be more highly tilled and fully worked, it will be necessary to make the same quantity of land more profitable and yield a larger return per acre, and therefore the pastoralist must sow down fifty or sixty species of grasses, where before he has sown only one or two, and the farmer, if he wishes to

grow meat as well as grain, must largely increase the number of his fodder plants; not only must he grow several kinds of *Sorghums*, Maizes, Millets, *Holcus*, *Andropogons*, *Panicums*, and other such plants in the hot weather of summer, and feed his live stock therefrom, but he must bury them in silos, as the French farmers do, for feed in the winter, and at that season he will have the advantage over other parts of the world of growing feed in the winter itself, by planting those things that will grow favourably in the late autumn, the winter itself, and the very early spring. The Sugar Beet, the Prickly Comfrey, Cabbages, Turnips, Swedes, Kohl Rabi, various kinds of Vetches, winter Oats, Cape Barley, Prairie Grass, and other Brome grasses, with some of the best of the indigenous grasses of New Zealand added thereto, supplemented by Italian Rye, Devon evergreen Rye, several *Poas*, *Anthoxanthums*, and many other grasses. While the several kinds of *Achillea*, *Pentria virgata*, the various salt bushes, *Apiums*, Carrots, *Menthas*, Thymes, and *Taraxacum* will act as condiment and medicinal herbs to the sheep and cattle depastured on the places where they grow.

And here we must remember the writings and experiences of persons in England and countries with as severe a climate, will not serve us, as the conditions of our colony and climate are altogether different. The orange, the *Eugenia*, the guava, and the olive, which cannot bear the winter climate of the places round Great Britain, will here grow in the open air, and stand our winter frost, as they have done for some years in my experimental ground, is a proof of our milder climate. We must therefore experiment for ourselves, and thus build up a system of agriculture and grazing suitable for the peculiarities of this colony. But without further dwelling upon the difference of climate in this country, and the necessity of a different procedure for farmers and graziers to that adopted in Great Britain, we will now consider a few more grasses and fodders that might be grown in our fields and farms with great advantage.

Agrostis solandri.—This grass is a native of Eastern Australia, is there spoken of very highly as of a nutritious quality, it grows there a quantity of herbage during the winter season, and my experience of it in my test cultivation was, that it was not only good as a winter grass during the cold weather in New Zealand, but that from the greater moisture here, it grows further into the summer season as well. It may, therefore, be described as a very good permanent pasture grass for autumn, winter, and spring growth, and thus is a valuable addition to our permanent mixed pasture grasses. There are several varieties which I received from Australia, some much better than others.

Agrostis stolonifera.—A grass found indigenous in Great Britain, which Sinclair, and other writers on grasses, brought into prominent notice as a

grass that would cause cows to produce very rich milk, and was then called "butter grass." It was much sown and cultivated in Ireland, and was there called "fiosin," and highly valued; but during the past fifty years the extensive drainage operations have made it less esteemed, and this has been brought about by the drains drying the land, and rendering it less suitable for its growth, but on damp lands it is very valuable, as my experiments prove to me. Wherever I sowed it, upon damp or swampy lands, it gave a very large amount of exceedingly valuable herbage, and was eagerly sought for by the animals, who fattened upon it rapidly. It has proved itself a good grass for damp, undrained, or swampy lands, also along the edges of streams, or creeks near ground too moist for other nutritious grasses to succeed.

Bromus emarginatus.—This excellent grass should be introduced into all mixed pastures, as it grows all through the winter season and withstands the ground-frosts that bring so many other grasses to a standstill, while its abundant foliage gives an amount of feed during the cold wet weather that live stock seem greatly to relish. We may look upon this as a very valuable winter grass in these latitudes, and a most useful introduction into all moderately open alluvial or loam lands.

Andropogon laniger.—This fine grass is indigenous in the various parts of Eastern Australia. When growing it here, I found it began to shoot when the warm weather set in, and continued to grow during the summer, and seeded in the autumn; its short thickly set leaves were much relished by sheep, horses, and cattle, and analysis showed they were nutritious and fattening.

Basuta grass.—The seed of this grass was sent me to test, and upon sowing it in tilled loamy soil it came up freely, and shooting out formed a thick sward; its seed ripened in abundance; this was sown down and rapidly covered the ground, showing that this climate suited it. It gives a large quantity of herbage, and is green here summer and winter, and if not too closely fed or cut down, always shows rapid growth; stock like it. I think it would be of great benefit mixed with other grasses as it holds its own place amongst them.

Bromus ciliare.—This fine fattening grass produces an abundance of seeds that are as large as those of prairie grass, and though it is of a more spreading habit than prairie grass, it resembles it in general character, but possesses the merit over prairie grass, that it will bear feeding by stock better, and is not so easily destroyed, still it is not so well adapted for close feeding as some other grasses named, but proves itself an excellent grass for hay. It grows all the winter and during summer, if the drought is not too long continued, and starts afresh after the least rain.

Ceratochloa exaltata.—A strong-growing perennial grass; is useful for introduction into perennial mixed grasses, as it possesses a peculiar taste that causes live stock to select it from other kinds, gives a variety constantly growing for them to choose from, and, as it is nutritious, it is well adapted for sowing with other kinds, as it grows late in the autumn and in the early spring, when other grasses are not growing.

Dactylis altica.—This grass has the habit and general character of the cocksfoot, but is better suited for stiffer soils, where the *Dactylis glomerata* does not so well succeed. It grows all the year, but least in the driest weather; makes quicker growth than the *Dactylis glomerata* in winter. It is a good grass for permanent pasture, and should be sown when the cocksfoot is not suitable.

Festuca aquatica.—This is a grass that should be sown down along the banks of rivers, creeks, streams, and other waters, as it will grow and thrive where no other grasses would succeed. It is much liked by stock, being fattening and nutritious; horses and cattle will eat it down to the ground, so that during summer not a blade can be seen, but the moment a shower comes the grass springs, and on all wet or occasionally wet ground, this grass ought to be sown.

Festuca billardieri.—An indigenous Australian grass, which I have found to be an excellent grass for permanent mixed pasture. It grows in the winter, spring, and autumn, and after every shower in the summer, at all seasons of its growth, will send up an abundance of highly-nutritious herbage, and is a grass all stock thrive on; it should be widely introduced. It is a producer of abundant seed, and will readily propagate itself if once fairly sown and fairly treated.

Glyceria aquatica.—This fine grass has proved itself with me a large producer of seed, by which it sows itself along the water-courses and swamps, sending out an abundance of green leaves all the year in all damp situations, so that the stock, in places where before only rushes and sedges grew, are able to keep themselves in good condition upon it. It is therefore a very desirable introduction into suitable places, as one of a mixture with others recommended for such situations, and where grasses suited for dry localities would fail.

Elymus arenarius.—This grass is an admirable introduction for all sandy lands, as it will help to fix shifting sand, and, with a little trouble at first, will make land available that otherwise would be useless; having procured seed of this *Elymus*, I sowed it, and having read the statement of writers, that it was worthless as a herbage plant, was surprised to learn that the cattle and sheep had eaten it down, and this they have continued to do, whenever they have been allowed to get at it. Upon analysing it, I was

astonished to find that it contained a considerable quantity of materials that the digestive organs would be able to convert into sugar and peptones, and that it would pass into their systems as nourishment, so that it is here not only a useful grass to fix sand, and grow where other grasses would not, but the conditions of this climate had made it a useful grass for live stock on places where other grasses would not live.

Poa aquatica.—This strong-growing water-grass is another of the useful grasses for wet, damp lands where other grasses will not grow, and should be sown as a mixture upon such wet places, as its season of greatest growth differs from that of others here described.

Poa aquatica of Australia.—This Australian water-grass is very different to the European *Poa aquatica*, but, having received the seed under this name and grown it, I found it a grass that, in damp situations, grew very fast in the hottest summer weather; it is therefore good to introduce it, as its season of strongest growth is different to the other water-grasses. It grows scarcely at all during cold weather in this colony.

Panicum longistylum.—This is a grass that should be introduced into permanent mixed pasture, as it grows during the autumn, when many other grasses are at rest, and continues here to throw up its singular seed-heads far on into the winter.

Paspalum scrobiculatum is also another very useful Australian grass, which grows well with me during the summer, and it would do well if introduced into permanent pasture; both stock and sheep like it. The Australian variety differs in several respects from the *Paspalum scrobiculatum* indigenous to New Zealand.

Phalaris bulbosa or *P. minor.*—This excellent perennial grass produces a large quantity of fine sweet foliage, very readily eaten by stock, and which quickly puts them in good condition. It keeps green far into the winter, even ripening its seed-heads in the late autumn. It is well worthy of introduction into permanent pastures, and its seeds, which are quite as large as the *Phalaris canariensis*, will, if this grass is made into hay, add to its nutritious qualities.

Danthonia penicillata.—A narrow-leaved native grass of Queensland, that seems in this climate to have changed its habits, and grows well through the autumn and winter, during which seasons its fine green foliage is picked out from the other grasses and eaten readily by cattle and sheep, and is useful in mixed pasture from its growing during the season when the many other grasses are at rest.

Festuca dimorpha is another of the grasses that it would be advisable to introduce, from its habit of winter growth, which makes it of value when feed is less abundant.

Festuca drymija.—This is also a grass that may be sown with advantage, as in the late summer rains, and in the autumn and winter, it disregards the frosts in these parts and goes on growing, sending up its leaves that supply a nutritive feed to the animals that are evidently glad to get it, and which thrive thereon.

Bromus giganteus.—I received seed of this grass from two different sources, namely, Great Britain and Australia. They appear to possess somewhat different habits of growth, although their botanical characters are similar, the British variety growing better in the late winter, and the kind from Australia best in the autumn, but both throwing up large quantities of tender succulent feed, bearing feeding by cattle well, but must not be too closely cropped by sheep. When sown down in permanent pasture they add greatly to the quantity of hay, both to its bulk as well as its nutritious qualities, and can therefore with advantage be introduced into permanent pastures.

There are several other bromes, and many other varieties of grasses that are suitable for the pastoralist to sow, and which I should like to mention, but must wait for another opportunity; and I will now pass on to those plants that will yield fodder to the farmer and others who may require them.

The *Symphytum asperrimum* (prickly comfrey) has of late years again received considerable attention, and wishing to test its value in New Zealand, I obtained roots of the different kinds from England, France, Australia and other places, and having got them, subjected them to test culture. They have grown and thriven well, and I have no doubt that this climate and the conditions it will find here, will suit it very well. I believe it will be a very valuable plant for using as fodder for cows to increase their milk, for feeding bullocks, horses, and sheep. There are several varieties have been sent me, some are more vigorous growers than others, they can be easily brought here in wardian, or such-like cases, with very few failures. My last consignment was a case containing one thousand small roots, they were four months before I could get them in their case. I had them put in the ground by common labourers, and yet over eight hundred of them are now growing, they have had no watering during warm weather, or other artificial care, as I wanted to try what they would do if planted out and left to themselves, and the result has been that they stood the driest, hottest, coldest, and most windy weather, and grew through it all, so that, bearing this rough treatment without any digging, manuring, hoeing, or other cultivating, and yet growing vigorously, they must be regarded as able to stand unfavourable conditions well, and if, with this treatment, they prove that they can keep a large number of live stock to the area upon which

they grow, and make them improve in condition quickly, they may then be regarded as a useful and good addition to our fodder plants, but as I never think much of any plant until it has had five or six years testing, it is too soon yet to say much in favour of this plant.

The *Prosopis pubescens*, or screw bean tree. As soon as I heard this plant was considered to be a useful one for fodder, I procured specimens and seed. The seeds vegetated, and the plants are growing slowly, so that in a few years we shall be able to learn whether it will grow freely in this country. I read of a strange test which was applied to try the use of this tree. A horse was given all he liked to eat of the pods with the seed in them, and he liked them so well that he ate about four pounds of the dry husks or screw pods. The result was what might have been expected. The horse was found dead the following morning. No doubt the same event would have occurred had the horse been fed with any other such dry material, and, although the horse's death was attributed by the writer to the poisonous effect of the screw bean, I think it was rather to be ascribed to the large amount of dry husk swallowed, as a horse has often killed himself by eating too freely wheat chaff, bran, or even whole wheat itself; so the death of this animal does not prove that the screw bean is poisonous, but that too large an amount of dry food becomes injurious to any animal partaking too freely of it. But there are better trees of this *Prosopis* genus than the screw bean, and some of them are found most excellent fodder for horses, and other live stock where they grow, and I intend to get them as soon as possible and try them here.

There are also among the plants that are worthy of culture as annuals by farmers for fodder to cut green, or to dry and make into hay, several of the millets that will do well here, and yield a large crop of herbage and seed, and that are readily eaten by horses, cattle, and sheep.

A *millet* from Queensland I tried. It began to grow in the spring, coming up very quickly; by the autumn it had ripened its seed; the herbage is tender, succulent, and relished by all stock; it grows about three feet high, shooting out thickly.

A *millet* from France much resembles the preceding, but bears a larger and more abundant seed; it sends out branches from the joints, which also seed; from the large quantity of seed and its succulent green stems and leaves, it proves itself a useful fodder-plant.

Milium effusum is another plant that gives a large quantity of seed, and as it will grow under trees or bush, it might be sown there in the place of other kinds not suitable; it also does well if grown with tares or vetches, and when cut together can be used as a fodder with great advantage.

Hungarian millet also does well here, and ripens its enormous heads of

seeds, and although if left to ripen, its seed-stalks are dry, and not so nutritious as the *Milium effusum*, yet the very great quantity of seed and heavy crop produced to the acre, makes it a plant worthy of culture for fodder in suitable places, and in rotation.

A large variety of *Vetches*, some of which I obtained from Malta, have proved themselves more prolific and of greater forage value than either the summer or winter vetches more usually grown, both for cutting when green and in the autumn cutting, and burying in pits or silos, as managed in France, and in the winter digging out and feeding stock on the farms. The farmers might greatly increase the numbers of live stock kept and fattened on the farm by adopting this plan.

Chicklin vetches I have found abundant bearers of seed, and a useful forage plant that all live stock will eat whenever they can get them, and it would fatten them quickly.

Having extended this paper to as great a length as I dare venture to trespass upon the Society's time, although there are so many other plants that deserve to be noticed and introduced, yet a notice of them must await a future opportunity if the Society should desire it.

ART. LIX.—*On Pituri, a new Vegetable Product that deserves further Investigation.* By S. M. CURL, M.D.

[Read before the Wellington Philosophical Society, 31st August, 1878.]

THE Wellington Philosophical Society being the recognised medium of bringing before the scientific and general public any scientific matter, I venture to urge upon its experimenting members the desirability of further investigating a peculiar vegetable substance called Pituri, that has lately been studied and investigated by myself and others.

Pituri consists of the dried leaves and other parts of plants that contain organic elements, and when swallowed by individuals, appears to enable them to sustain a severer and more continued exertion than they would be able to bear without its use.

It has been long known to those acquainted with the habits of the aboriginals of Australia, that they used a substance bearing in the different tribes different names; that when they were going upon long journeys over desert tracks, where they would not be able to get food or water, or when they were about to undertake any unusual exertion, or when any question of moment to them would require more mental exertion than usual, or

when in short they would be called upon to sustain any severe strain upon their mental or physical power, they would then take out of a bag, in which they carried it, some dried vegetable substance, and would chew or masticate small quantities of it, and would at intervals during their desert travel masticate and swallow small portions of this substance, and they could thus for days sustain themselves without food, until they could reach places where food, etc., was again procurable.

It is further known that the individuals of the several tribes valued this material very highly, and that they obtained it from a distant tribe, paying for it by a kind of barter, and that the users did not know the plant from which it was gathered.

The knowledge of these facts had caused various scientific persons in Australia—Baron von Müeller, Dr. Bancroft, and others—to be very desirous to learn more about this material, and to investigate its properties.

When Mr. Gilmore upon one occasion was travelling, he came across a tribe who, being remarkable in other respects, claimed to have certain of their old men who knew where the Pituri was procured, and the plants from which it was obtained. Mr. Gilmore was afterwards fortunate enough to procure specimens of the dried Pituri, and gave portions to several scientific persons to experiment with.

Dr. Bancroft made several very interesting experiments with this material, both in its dried state and also with an extract prepared from it.

Baron von Müeller, having received a portion and examined it microscopically and otherwise, believed that a considerable part of the dried substance was the leaf of a small tree or shrub, which he defined as *Duboisia hopwoodii*, which is indigenous in several of the warmer parts of Australia. Having procured, through the kindness of Mr. Barley, a supply of the dried Pituri, I was able to investigate it, and to confirm the results obtained by Dr. Bancroft to some extent, which results shall be as briefly as possible related hereunder, with a view to inducing all who have the means to further investigate this very curious, and as it appears, very important substance, which promises not only to be a very valuable medicinal remedy, but to be what it is claimed the coca of the Peruvians is (the dried leaves of the *Erythoxylon coca*), a nervine and stimulant that sustains function, and retards tissue waste.

Before giving the results of my experiments with Pituri, it will be well to see what Baron von Müeller and others say of it.

"The natives of Central Australia chew the leaves of *Duboisia hopwoodii*, just like the Peruvians, and Chilians masticate the leaves of the coca (*Erythoxylon coca*) to invigorate themselves during their long foot-journeys through the desert. I am not certain whether the aboriginals of all districts

in which the Pituri grows are really aware of its stimulating power. Those living near the Barcoo, travel many days' journey to obtain this to them precious foliage, which is carried always about by them broken into small fragments and tied up in little bags. It is not impossible that a new and perhaps important medicinal plant is thus gained. The blacks use the *Duboisia* to excite their courage in warfare ; a large dose infuriates them.

"(Signed) FERD. VON MUELLER.

"15th February, 1877."*

Mr. W. O. Hodgkinson, writing to Dr. Bancroft on February 15, 1877, after giving a description of the localities where he found the plant, etc., says :—"The resident natives carry on a considerable traffic in this plant, representatives of tribes from other quarters coming to procure it. It is used, after being sweated beneath a coating of fine sand, as a narcotic stimulant, strictly kept for the solace of the old men, or for occasions when long privations have to be endured, or some solemnity performed. * * * * * When used on the march, a portion is put into the mouth chewed, until it assumes the form and consistency of a sailor's quid, passed round each one of the party, the saliva promoted by its use being swallowed. * * * * * When with Burke and Wills' expedition, subsequently with Mr. John McKinlay, and recently in the North West Expedition, I used Petchere, or Petury, or Pituri, habitually when procurable, in default of tobacco, and have very often chewed it both in its raw and prepared state."

Dr. Bancroft tried experiments upon dogs, cats, rats, and frogs, and gives the results of its effects upon them :—

"1st. Period of preliminary excitement from apparent loss of inhibitory power of the cerebrum, attended with rapid respiration ; in cats and dogs with vomiting and profuse secretion of saliva ; in dogs there is retraction of the eye-ball.

"2nd. Irregular muscular action, followed by general convulsion.

"3rd. Paralysis of respiratory function of medulla.

"4th. Death ; or

"5th. Sighing inspirations at long intervals.

"6th. Rapid respiration, and returning consciousness.

"7th. Normal respiration, and general torpidity, not unattended with danger to life.

"Death is caused chiefly as in tetanus, by excessive contraction of the respiratory muscles and suffocation. Pituri does not dilate the pupil when applied locally, though dilation is seen to some extent. When given by subcutaneous injection, the extreme retraction of the eye-ball in dogs is very remarkable." He goes on to say :—"In small medicinal doses we

* This was in a letter to the Editor of the Australian *Medical Journal.*

may expect to find the period of excitement and the torpidity to be the only marked symptoms." And further he adds:—"Of the medicinal uses of Pituri little at present can be said. I have given it in some cases of extreme debility, but in doses much too small to enable me to speak of its value. I would expect it to be a tonic nervine, that could be used along with alcohol."

My experiments with Pituri were made with the leaves themselves, with the infusion, and with the extract of the leaves, and were performed upon domestic animals and myself. The results were somewhat similar to those of the gentlemen herein referred to; but as I had not a sufficiency of the Pituri for a very extensive series of experiments, I used up what I had, and am waiting for a further supply before continuing others. The results I have at present arrived at are: When the leaves are chewed by a man unaccustomed to its use, it excites increased flow of saliva; a slight dilation of the pupil; the heart's action is accelerated, the beats being increased in number by from five to eight in the minute; a pain in the hind part of the head is felt; the respirations are reduced in volume; there is slight nausea.

These symptoms pass off after a short time. Then is felt increased muscular irritability; a feeling of greater power; an inclination exists to move the muscles in some vigorous manner; the heart beats stronger; the diaphragm acts more forcibly; respiration is performed slower; muscular exertion is more easily done, and greater exertion can be made without fatigue; a desire for muscular movement continues for a long time; partial anæsthesia of the skin is felt for some hours; sense of touch is lessened; no feeling of hunger or thirst is felt, if food or drink is not taken for twenty-four hours; the excretions are decreased in quantity, and chemical constituents altered; there is less carbonic acid in the air expired than normal.

If the extract or infusion is given to animals so that it enters their system by the digestive organs, much the same train of symptoms is observed; but if it is injected subcutaneously, then the symptoms more nearly approach those described from the observations of Dr. Bancroft.

From such experiments as I have hitherto been able to make, I have no doubt that the active principles of the Pituri, acting as it does upon the great nerve centres and ganglions, and also on the muscles, increasing the irritability of their muscular fibre elements, and while it is acting upon the nerves and muscles, the growth of cells is retarded, and thus tissue change is modified and lessened, the individual under its influence being thus able to undergo exertion without food, which without it, he could not sustain.

It is, therefore, one of the few active agents that hereafter will be of considerable service to the physician and others, that when properly given or used, will prolong and preserve life, by carrying on the organic functions

over the crises of diseases, or enable exertion or effort to be sustained, when without it death or very severe disease would ensue. But it will be well here to insist that it be in all cases swallowed, and not used by subcutaneous injection, as it thus acts quite differently in some respects, and is modified in others, and would always be better given medicinally in that way, than when subcutaneously injected, as when swallowed it is mixed with the saliva and gastric fluids, which modify its action, whereas if injected under the skin it is absorbed, and acts in a different, as well as a more sudden and violent manner. I am not now able to speak as to the doses that will be most beneficial, as my supply of Pituri is exhausted, but small and repeated doses of the leaves, or a powder thereof masticated, or mixed with some linctus, or in the form of lozenges, so that it will be well mixed with the saliva, are the best forms of using it. But as it can be more fully studied, no doubt other facts will reveal themselves with regard to it and to its uses and proper place in the *materia medica*. At all events, if these observations cause others to examine this important agent, and when it is better known, and health is gained or life is saved by this drug, my object in bringing this matter before the Society will be gained.

Art. LX.—*Notes on Cleistogamic Flowers of the Genus* Viola.

By George M. Thomson.

[*Read before the Otago Institute, 14th May*, 1878.]

It is a well-known fact that, owing to the poverty of insect life in these islands, the number of *entomophilous* plants, *i.e.*, those requiring insect aid in securing fertilization, is small in comparison with most other parts of the world. Hence, also, the comparative want of gaily-coloured flowers, and the prevalence of white, green, and inconspicuous flowers. As every fact bearing on the question of fertilization of flowers gives us additional insight into the relations of the indigenous fauna and flora, I make no further apology for communicating the following notes to the Institute.

There are many plants which produce two kinds of hermaphrodite flowers, viz., tolerably large and conspicuous flowers, fitted for cross-fertilization by means of insects, and small, closed ones, more or less depauperated, and sometimes produced underground, fitted only for self-fertilization. These last are known as *Cleistogamic* (Gr. *kleistos*, closed; *gamos*, union). In Darwin's latest botanical work, "On Different Forms of Flowers," there is given a list of fifty-five genera, certain species of which produce these flowers. Of the genus *Viola*, fifteen species are named, which produce,

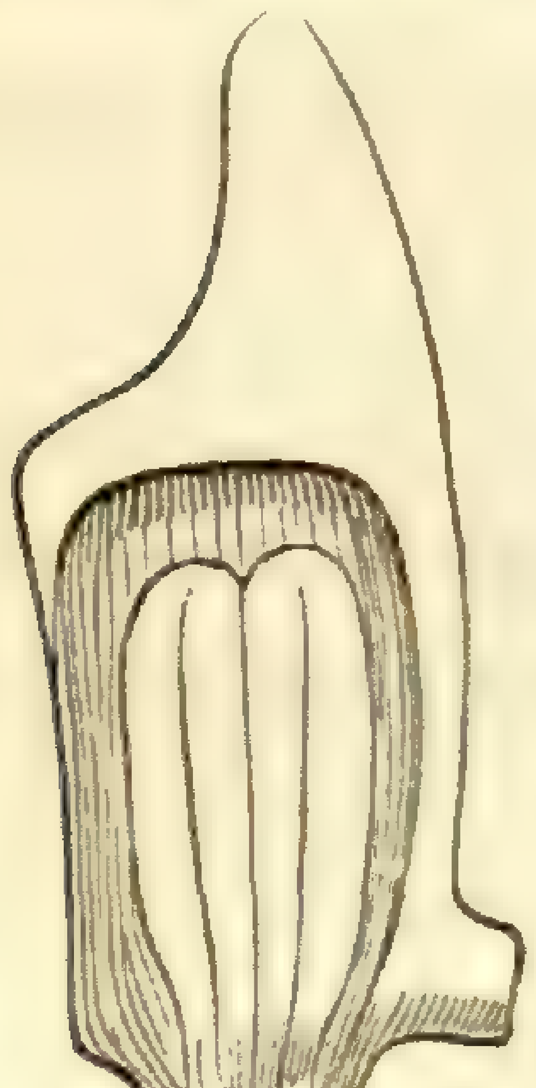
more or less completely, cleistogamic flowers. *V. tricolor*, the parent plant of our garden pansy, does not produce them, and we find in the above list a gradation in the amount of depauperation, which appears to reach its maximum in the Indian *V. nana*. This species, though producing perfect flowers in its native habitat in the Sikkim Terai, produced only cleistogamic flowers in Calcutta, and in Mr. Darwin's greenhouse, and this for many successive seasons.

Three species of *Viola* have been described as occurring in New Zealand. Of these I have not seen *V. lyalli*, but have examined the other two. The presence of cleistogamic flowers on these plants has long been known, but their structure has not been minutely described, and most people take them for buds.

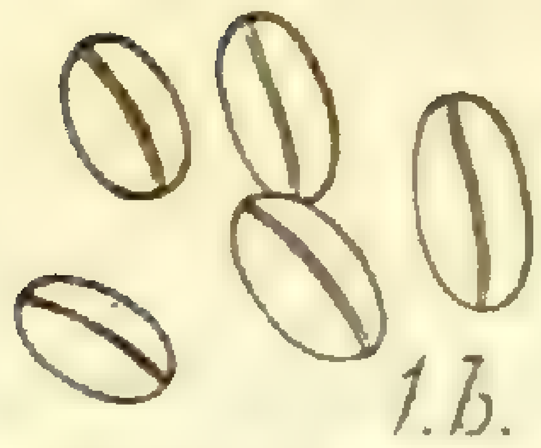
Viola filicaulis, Hook. f.

This species bears exceedingly variable flowers, some being only slightly depauperated, while others are completely closed. I am strongly inclined to think that those plants which grow in open, sunny spots, produce more of the conspicuous flowers than those growing in hidden and out-of-the-way corners. Clumps of the plant were in many cases gathered from deep clefts among rocks, and these were found in most cases to be covered with cleistogamic flowers, but to have few or none of the conspicuous ones.

The ordinary flowers of this plant are produced on slender peduncles from three to six inches in length.



1.a.



1.b.

1, *a*. Spurred stamen from conspicuous flower of *V. vilicaulis* × 25.

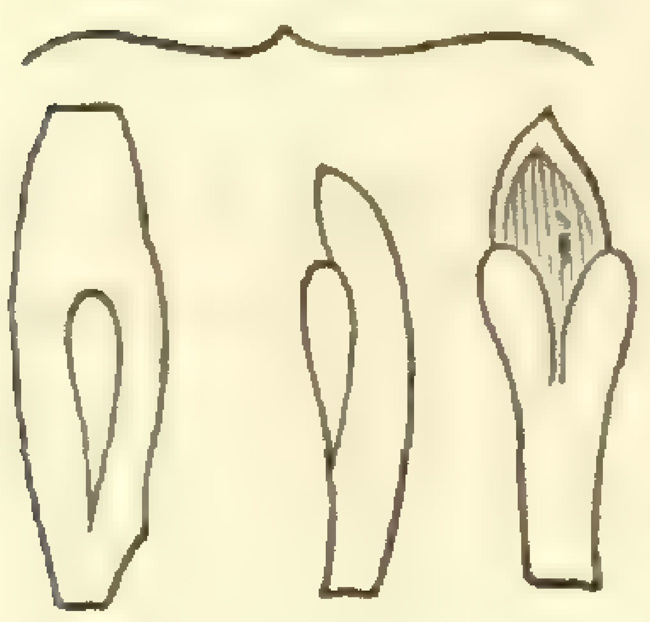
1, *b*. Pollen grains from the same × 225.

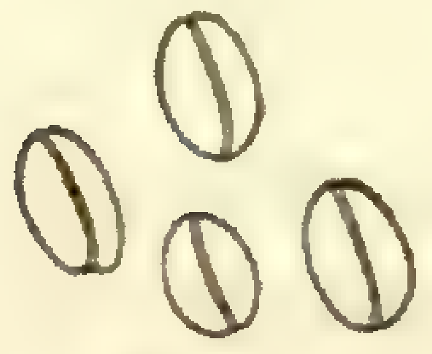
The petals, which are about twice as long as the sepals, are white or pale blue, elegantly streaked with brown and yellow; the lower one being furnished with a very short, obtuse spur. The stamens are well developed, with a thin, broad connective, which extends considerably above the anther lobes, and the two lower stamens are furnished with short, truncate spurs. The style is long and curved, and terminated by a quadrangular stigmatic aperture.

The cleistogamic flowers are borne on curved peduncles, very close to the root, from ¼ to 1 inch in length. The flowers themselves are very small, seldom exceeding a quarter of an inch in length. The sepals are similar in form and development to those of the ordinary flowers. The petals are shorter than and included in the sepals, and are all regular in shape. The stamens appear to be all represented, but none have the spur. The filaments are narrow, not extended laterally, but prolonged shortly above the anthers to a short, acute hood. The anthers are applied closely to the pistil, and the pollen grains,

while still in the anther cells, may be seen emitting their tubes to the stigma. The style is nearly as long as that of the conspicuous flowers, but in order to bring the stigma within reach of the pollen, it lies coiled and twisted on the summit of the ovary. In some of the flowers all the stamens were reduced to mere filaments except one; in others there occurs one stamen with both anthers; another with a single anther, the rest being represented by filaments; while others again had the rudiments of anthers, but no pollen. The size of the pollen grains varied somewhat in the two kinds of flowers. In the large, conspicuous flowers, the grains appeared uniform in size and in shape, and averaged about $\frac{1}{600}$th of an inch in length; in the cleistogamic flowers, the larger grains were similar in shape and length to those of the larger flowers, while the majority were rounder and thicker, and not more than $\frac{1}{1000}$th of an inch in length.

2.*a.*





2.*b.*

2, *a.* Stamens from cleistogamic flowers of *V. filicaulis* × 25.

2, *b.* Pollen grains from the same × 225.

Viola cunninghamii, Hook. f.

This species, as a rule, flowers earlier than the preceding. When examined by me during the month of January, it bore abundance of cleistogamic flowers, while the empty valves of their capsules showed that the other flowers had already ripened and shed their seed. The ordinary flowers are very similar to those of *V. filicaulis*, and are produced on peduncles of similar length. The cleistogamic flowers are produced on very short peduncles, which lengthen in fruit to ½ or ¾ of an inch. All the parts in these flowers are very small. The sepals are all present, and of the normal form, but the petals are wanting; their disappearance seems to be complete, as there was no trace of their presence.

The stamens are very feebly developed. Two of them have both their anthers developed, but these are very small and do not contain much pollen. The filament is narrow below, but has its upper part extended into a hood. These two stamens are placed on opposite sides of the pistil, and their hoods completely overlap and enclose it, their anthers being in contact with the short, obtuse stigma.

In all the flowers examined by me, there seemed no departure from this type of structure, nor was there the variability which I noticed in the cleistogamic flowers of *V. filicaulis*.

3.*a.*

3.*b.*

3, *a.* Hooded stamen from cleistogamic flower of *V. cunninghamii* × 25.

3, *b.* Rudimentary stamen from the same × 25.

Art. LXI.—*On the means of Fertilization among some New Zealand Orchids.*

By G. M. Thomson.

[*Read before the Otago Institute, 11th June,* 1878.]

The following notes drawn up from jottings made during the past spring and summer, are by no means exhaustive, but may rather be looked upon as a small contribution to our already existing information on this interesting subject.

Of the eleven genera which are represented in this part of the island, I have made more or less lengthened observations on ten, viz.: *Earina*, *Dendrobium*, *Corysanthes*, *Microtis*, *Caladenia*, *Pterostylis*, *Chiloglottis*, *Lyperanthus*, *Thelymitra* and *Prasophyllum*. I was not fortunate enough to obtain specimens of *Gastrodia*, which is a very readily overlooked plant.

Some of my specimens were cultivated, and thus yielded more certain information than those which were examined in the wild state.

One fact which has struck me during these investigations is, that I have hardly ever been able to capture insects carrying pollen on any part of their body. Only when examining beds of *Corysanthes* have I found insects with pollinia. It is possible that the general coldness of the past season, and the remarkable scarcity of all kinds of insects, have had a good deal to do with this. If this is the case, of course a disturbing element has been introduced to some extent into my observations.

Tribe Epidendreæ.

(1.) *Earina autumnalis.*

I have had a large clump of this species in cultivation all summer, but owing probably to the want of warmth it only came into bloom towards the end of March. It produced abundance of flowers, however, having about 1100 on it when examined on 6th April.

The flowers are only about ⅓ of an inch in diameter, white in colour, with a yellow centre, and with an almost over-poweringly sweet perfume. The labellum is 3-lobed, stands nearly erect in front of the column, and has its lateral lobes produced forward at right angles to it. It bears two strongly marked longitudinal ridges on its surface, which almost touch the sides of the column, and leave a minute nearly square passage to its base. There is no nectary, but the tissue at the base of the labellum is easily punctured, and exudes beads of moisture. The column is short and erect, the stigmatic surface very concave, with the viscid rostellum projecting prominently forward above it. The anther is terminal and deciduous, and encloses four pyriform pollinia attached in pairs to a short caudicle.

From the position of the parts it appears to be impossible that self-fertilization could take place. The pollinia are remarkably coherent, and

lie very closely ensconced in the anther case. For fertilization by insects, however, the parts are very simply fitted. The rostellum with the attached caudicle projects to a small point, and is viscid on the edge and under-surface. An insect visiting the flower would insert its head or proboscis into the small square aperture between the labellum and the column, and in withdrawing would inevitably touch the viscid surface. The slightest touch brings away the pollinia, usually all four, but sometimes only two. Were they to be withdrawn just as they lie on the summit of the column, they would hardly be in the position to strike the stigmatic surface of another flower; but in being withdrawn, the cap of the anther pulls them slightly downwards and depresses the caudicle considerably. I repeatedly imitated the action with the point of a pencil or needle, and found in every case that the pollinia came away readily, and were depressed considerably below a right-angle to the surface to which they adhered. In this position they were easily placed on the stigma of a second flower. I carefully examined 91 flowers, and found that the pollinia had been removed from the anthers in 41 cases, and remained intact in 50; this too in bright, warm weather. Of course the plants were not in their native habitat, which might account partly for lack of the usual bush-frequenting insects. Those spikes prominently placed on the plant usually had the pollinia of their flowers more or less removed, while those which were buried among the leaves had not as a rule been visited.

Tribe Malaxeæ.

(2.) *Dendrobium cunninghamii.*

This beautiful orchid has its flowers evidently fitted for cross-fertilization. The upper sepal is lanceolate in form, and is the smallest in the whorl. The lateral sepals are broad at the base, and adnate to the produced base of the column. The lateral petals are linear oblong. The labellum is widely expanded above the middle, with two small lateral lobes, and bears on its face five elevated ridges or plates. It is attached to the base of the column by a short and very elastic claw. The column stands in the flower exactly like the letter J, being produced forward at the base, and terminated by a large green glandular swelling. When the flower is open, a small drop of nectar is always found at the base of this swelling. The erect portion or limb of the column is rather long. The anther is terminal, and encloses four narrow and flattish pollen masses, attached in pairs to a strap-shaped caudicle. The stigmatic surface is placed slightly below it, and is nearly square. When in the bud, the lower surface is hollowed into a deep pit, and on its summit, standing directly in front of the bases of the pollinia, is the rostellum, which at this early stage is membranous. As the flower opens, the cells

of the rostellum become converted into a milky and excessively viscid substance, while the whole surface of the stigma secretes abundantly a clear, viscid matter, and a drop of sweet fluid is secreted at the base of the column.

The action of the parts is exceedingly simple. An insect alighting on the labellum weighs it down very easily, and thus gains access to the nectar at its base. The elasticity of the labellum, however, tends to keep it pressing against the column, and thus compels the insect to brush against the viscid rostellum. The pollinia are very easily withdrawn by an upward movement, as can be seen by introducing a needle or pencil point, and touching the rostellum in withdrawing it, when one or more of the pollinia will be withdrawn with it. The lateral lobes of the labellum and the guiding ridges on its surface would prevent an insect reaching the nectar without touching the rostellum when leaving the flower; and any insect entering another flower with pollinia on its head, could not fail to leave these on the stigma. By inserting a fly, this action was easily seen, all four pollinia being withdrawn, with their caudicle glued over the insect's right eye. Out of twenty-two flowers examined, only five had their pollinia removed from the anther cases, but as the plant was growing on a veranda away from its native habitat, this was no criterion. I regret that I did not fertilize any of the flowers on this plant with their own pollen. Those fertilized by pollen from other flowers on the same plant produced fine capsules.

Tribe Arethuseæ.

(3.) *Corysanthes macrantha.*

Both this species and *C. rivularis* were examined by me, but the flowers are almost identical in structure, the difference not affecting the relations of the parts. They are very striking in appearance, owing to their lurid purple colour, and the long twisted sepals and petals, which give them an extraordinary resemblance to a large spider sitting on a leaf. The upper sepal is large, prominent, and helmet-shaped, and projects forward over the flower. The labellum is large and involute, almost semi-cylindrical, with its external margin fimbriated and expanded downwards into a longish tip. It is not attached continuously at its base. On each side of the flower, when in bud, a small slit is seen, which widens by an expansion of the margin (which is thus caused to arch slightly outwards) into a small circular aperture. By the contact of the in-turned edges of the labellum, and the overlapping of the upper sepal, a horizontal aperture is left in the mouth of the flower, which bends at right-angles a little way in, and opens into a tolerably large cavity. Placed quite at the bottom of this is the short, thick column, lying almost horizontally in *C. rivularis*, and somewhat more erect in *C. macrantha*. The stigmatic cavity is deep, and on its posterior

margin is the rostellum. This is formed of large cells, covered with a very delicate membrane. If this be touched with a bristle, it is almost instantly ruptured, and a small, very viscid drop of matter exudes. In withdrawing the bristle the pollinia are brought away with it. The anther is terminal (posterior), and has broad lateral projections. The pollinia are four in number, in two pairs, and in the form of plates. The flowers do not appear to secrete any nectar, but when the surface of the labellum is slightly punctured, a considerable amount of sweetish purple juice exudes, which is probably grateful to insects. From the shape of the flowers, it is necessary to cut them longitudinally to see the parts. Looking at the position of the anther and stigma, it appears to me almost impossible that self-fertilization can take place ; at the same time it is somewhat difficult to suggest any satisfactory way in which an insect could accomplish either this or cross-fertilization. I presume that any insect entering the flower would have to back out again by the same way as it entered, and in doing so it would come in contact with the rostellum, and would remove the pollinia on its head. It is also probable that, in endeavouring to obtain from a second flower any of the sweet juices from the tissue at the base of the labellum, it would slightly advance its head, so as to bring the pollinia attached to it on to the stigma. Again, it is possible that self-fertilization might be secured by an insect thus getting the pollinia on its head, and then endeavouring to push its way down through the small lateral apertures. In doing so, it would almost certainly smear the stigma with pollen from the same flower, and I have sometimes been inclined to think that such did take place. At the same time, this would seem like putting an unnecessary difficulty in the way of what is usually a very simple process, and therefore no great value is to be attached to this idea.

For a time I could not understand why spiders frequented these flowers so much, but I soon found a sufficient cause. The only insects capable of removing pollen which were found about the flowers were small Diptera—probably a species of *Culex*. In several cases these small flies had penetrated into the tube of the flower, and, in their eagerness after the sweet juices found there, brought their heads in contact with both rostellum and stigma, and partly owing to the viscidity of these parts, and partly to the narrowness and bending of the tube, were unable to withdraw backwards. In some flowers insects were thus found still alive, in others they were dead, while in many others only portions of them, such as legs, wings, etc., were left, the spiders having devoured the rest. In every case in which a captured insect was withdrawn from its trap, the pollinia were removed also, securely attached to the front of the head.

I closely examined 143 flowers, and found that in 47 the pollinia were

still in the anther cells; from 90 they had been removed, while in 6, dead or living insects were found glued to the stigma. Of the whole number examined, only a small proportion ultimately produced capsules.

The flowers of this genus will well repay examination.

(4.) *Microtis porrifolia.*

In the flowers of this species the column is protected by a broad, flat hood, formed by the posterior sepal and the two lateral petals. The lateral sepals are completely reflexed, and lie back against the ovary. The labellum is large and pendulous, hanging out from the front of the flower like a tongue. It is rectangular in shape, rather longer than broad, with the margin crimped and curled, and bearing three glandular projections on its surface. Two of these are situated together near the base, and enclose a small depression or pit. This, from its position and appearance, I take to be a nectary, but I was unable to detect any liquid in it. The third gland is formed by an irregular wart-like mass of cells, and is situated near the apex of the labellum. I have not investigated its functions, nor do I know how its presence can be accounted for. The column is very short, and stands almost square, this appearance being caused by the wings or auricles which stand up on each side. Beneath these is the hooded anther, enclosing four pollinia, which lie very loosely in their cells. They present the appearance of two masses, but each is composed of a large outer and a smaller inner sheet, of a reniform shape, united by their threads to a short caudicle. In front of and somewhat below them is the viscid rostellum, towards the apex of which a minute white point is visible, which marks their point of attachment. The rostellum projects considerably outwards, so that the stigmatic surface is placed in a recess. The slightest touch on the viscid disc suffices to bring away one or both pollinia, the matter being excessively viscid. An insect alighting on the rostellum, and advancing its head to examine the glands at its base, would be certain to touch the rostellum and bring away the pollinia. These fall slightly by their own weight, so that on entering a second flower, they would be in such a position on the front of the insect's head as to touch the stigma immediately under the rostellum. In the first spike examined by me, 32 flowers were fully opened, and all but the top one had their pollinia removed.

Even when not fertilized by insects however, these flowers are readily self-fertilized, and during the past season this appears to have been the case with the great majority. After a time, the pollinia appear withered and brown, and somewhat dragged forward from their anther cells, while the ovary begins to enlarge, showing that pollination has taken place. If such flowers are examined carefully, it will be found that the pollen grains have emitted a great mass of tubes, which penetrate the upper margin of

the stigma, thus ensuring fertilization. I found this to be the case in several hundred flowers which I examined. The position of the labellum on the underside of this flower is caused by the usual twisting of the pedicel or ovary, which is so common in many orchids. But in young buds the posterior sepal is lowest and placed on the side farthest from the axis of the spike; and it is during the gradual maturing of the flower that the twisting takes place, so that, by the time it opens, the labellum and posterior sepal have changed places.

This species, as might be expected from its facilities for reproduction, is one of the commonest plants of the class.

(5.) *Caladenia bifolia.*

Chiloglottis traversii, Müeller.

This is a most abundant orchid in upland districts at an elevation of 1500 to 3000 feet. The flower is solitary on an erect scape, three to four inches in height. The upper sepal is obtuse, somewhat arched forward, and slightly keeled. The lateral sepals are placed under the labellum, and extend forward almost horizontally. The labellum is broad; on each side of the expanded portion is a yellow-coloured patch bearing two or three brownish spots, while extending from the middle to the base are two rows of yellow glands. The column is long and erect, slightly winged above, and bearing a terminal anther which encloses four pollinia. The stigma is rounded and slightly hollowed out, and is placed in close contiguity to the anther. The arrangement of the parts is so simple that an insect alighting on the labellum and advancing its head into the base of the flower could hardly fail to remove the pollinia; nor could one entering with pollen on its head fail to leave these on the stigma, for in withdrawing pollinia from a flower they are always slightly depressed by the cap of the anther. The pollen of this plant is very incoherent, and the lower surface of the stigma projects a little, so that I am inclined to think self-fertilization takes place in flowers which have not been visited by insects. The majority of the flowers appear to set good capsules, and flowers which I fertilized artificially, produced good full seed-vessels. I examined one sunny day twenty-two flowers growing in the open; of these only three had both pollinia removed; in one the pollinia were removed from one anther lobe; in five others the pollen masses appeared more or less disturbed; while in the remaining thirteen the anthers were untouched.

(6.) *Pterostylis banksii.*

The fertilization of the flowers of this genus has been so well described by Mr. Cheeseman, in the Trans. N.Z. Inst., Vol. V., p. 352, that I cannot well add to it, but my observations on them more than ever induce me to consider that there has been an unusual scarcity of insect life during the

past season. Out of all the flowers of the above species, and of *P. graminea*, examined, *not one* had the pollinia removed. The flowers are incapable of self-fertilization. Certain experiments made by me to test whether they were fertile with their own pollen were rendered useless by being conducted in the open, where the flowers were liable to be destroyed.

The rostellum of this orchid, when examined in bud, lies in front of and between the bases of the pollinia, but quite separate from them. At this early stage it consists of an oblong, pearly-white body, composed of large rounded cells, filled with granular fluid. The pollinia stand in a small hollow on the top of the column, and at this stage are attached only by a small posterior ligament at their base.

(7.) *Chiloglottis cornuta.*

In this species the flower is solitary, on a short scape, which lengthens after flowering, and is partly covered by an acute, sheathing bract. When fully developed, all the parts stand nearly erect, and thus leave no landing place for insects. The labellum is acutely trowel-shaped, with one broad central, and several narrow, lateral, longitudinal, purple glands. The column is curved back at the base, and then ascends in front of the upper sepal. The stigmatic surface is large, almost circular, quite flat and excessively viscid, there being no distinct rostellum. The anther is terminal, and encloses four plate-like pollinia, which are coherent, and are attached by their bases to the upper margin of the stigma (rostellum). Before the flower is open, and while yet almost sessile, and sheathed by the bract, the stigmatic surface becomes excessively viscid, and smears all the portion of the labellum immediately opposite to it. I could not ascertain how the pollen got on to the stigma, but in the few flowers I was enabled to examine, all four pollinia were on the stigma, and the anther cells were empty.

From the position of the flower when the parts are ripe for pollination, viz., low down between the two leaves, from its inconspicuous greenish colour, and the fact that viscidity is strongest in the unopened flowers, I am of opinion that this species is exclusively adapted for self-fertilization. The subsequent lengthening of the scape is probably only to aid in the dispersion of the seed.

(8.) *Lyperanthus antarcticus.*

In this orchid the flowers are solitary, or two on a scape, partially covered by a relatively large concave bract, and of a green colour throughout. The posterior sepal is large and broad, arched forward, and covering the column like a hood. The labellum is flat, broadly ovate and acute, quite glabrous, with two lateral and four median ridges. The column is broad, somewhat arched forward, and terminated by the acute anther. The rostellum placed directly above the stigmatic chamber, impinges on the base

of the anther, and is slightly viscid. The pollen-masses, four in number, are very incoherent. From their inconspicuous colour, the fact of their being very frequently closed, and the extreme incoherence of their pollen, I am inclined to think that the flowers of this plant are always self-fertilized. I examined 39 flowers, and found that the pollinia were present in all of them, but in the more advanced some of the pollen was scattered over the stigmas, and the ovaries appeared well-developed.

Tribe Neotteæ.

(9.) *Thelymitra longifolia.*

The fertilization of this orchid is treated of in Fitzgerald's "Australian Orchids," and quoted by Darwin. All the parts of the perianth, including the labellum, are similar in colour and shape. The column is nearly erect, and slightly hooded at the apex. On its front margin, and a little below the apex, a projection occurs on each side, bearing a tuft of exquisitely beautiful feathery hairs. These are the auricles or staminodia which represent two out of the three stamens of the inner whorl, the third being the only stamen fully developed. In this flower they form a very conspicuous feature, but I do not know their function, if any. Placed quite in at the back and near the base of the column, are the two persistent anther lobes. In very young buds these contain the pollinia, but as they approach maturity they become attached to the back of the stigma, which stands forward a slight distance from the column. The pollinia are composed of four sheets or plates of white, powdery, very incoherent pollen. The rostellum is hardly viscid at all, nor would this be of any use to the plant, as it is seldom, if ever, visited by insects. The flowers are seldom found open, and as a rule are probably self-fertilized. I presume that the pollen grains emit their tubes to the upper surface of the stigma, but I never succeeded in detecting this.

(10.) *Prasophyllum colensoi.*

The flowers are small and greenish-brown in colour. The base of the ovary is sheathed by a short truncate bract; the very short pedicel is not twisted, so that, as in *Thelymitra*, the labellum appears in its normal position above the flower. All the parts of the perianth are similar in form and colour. The column is very short and erect, with the anther placed at the back. At each side rises a small two-lobed appendage, representing a staminodium or imperfect stamen about half the height of the column. The stigmatic surface is broadly triangular, and is protected in front by the labellum, and latterly by the staminodia. The pollen grains are usually found adhering to the back of the stigma, some on its upper edge. When examined under the microscope, some of these were found to have emitted a mass of short tubes. The pollinia are two in number, and the

pollen grains forming them are bound together into small wedge-shaped masses. The flowers are somewhat sweet-scented, and though dull-coloured are tolerably conspicuous, but there appears to be no trace of a nectary. Nor from the position of the parts is it very probable that an insect could remove the pollinia, so as to place the loose, incoherent grains on the stigma of another flower. The species is evidently well fitted for self-fertilization. In nine spikes examined by me, containing altogether 75 open flowers, only four appeared to have the pollinia partially removed, and, even in these, pollen grains were adhering to the stigma and anthers.

Imperfect as the foregoing notes are, they still point to the correctness of the general principle that where it is advantageous to a plant to have its flowers cross-fertilized by pollen from another plant, there we find agencies for attracting suitable insects. Thus *Earina* has conspicuous flowers, sweet scent, and succulent tissue at the base of the flower; *Dendrobium* has showy flowers and a tolerably perfect nectary; while *Corysanthes* has conspicuous flowers and sweet juice. In all three, assistance from insects appears to be absolutely necessary. Again, *Caladenia*, which appears to be fitted for both means of fertilization, has tolerably conspicuous flowers, while *Microtis*, which is similarly favoured, has the rudiments of a nectary, but the former would seem to be more dependent on insect aid than the latter. In *Pterostylis* there seems to be nothing to attract insects, as the flowers are green, and, as pointed out by Mr. Cheeseman, do not appear to secrete any nectar, nor do they have any decided scent. Yet in none of the New Zealand orchids are the appliances to secure the desired end so perfect or so complex. In this plant only one species of insect appears adapted to each particular species of the genus. It would be interesting to discover whether this applies to other New Zealand genera. In those genera which are almost, if not altogether, exclusively self-fertilized, no special provision for attracting insects occurs, if we except the handsome perianth of *Thelymitra*.

Art. LXII.—*Description of a new Species of* Coprosma.

By D. Petrie, M.A.

[*Read before the Otago Institute, 8th October, 1878.*]

Coprosma virescens, Petrie.

A compact shrub, six to ten feet high, with numerous interlaced, slender, tortuous branches and twigs and greenish glabrous bark; leaves glabrous, membranous, elliptico-spathulate, quarter of an inch long or less, in distichous fascicles on the twigs; stipules connate, forming a short two-lobed tube around the twigs.

Male flowers terminal on the short lateral branchlets, in fascicles of three or sometimes more; each fascicle enclosed at its base by a cupular involucel, apparently formed of metamorphosed stipules; calyx short, cupular, with four or fewer short blunt lobes; corolla bell-shaped, four-partite almost to base; stamens exserted; the fascicles of male are often on twigs destitute of leaves.

Female flowers terminal on the short lateral branches, usually solitary, but sometimes two or three together, with a four-lobed tubular more or less ciliated involucel enclosing the calyx; calyx tubular, indistinctly four-lobed at the ciliated margin; corolla four-partite to base; the lobes narrow, oblong; styles papillose, twice as long as the corolla lobes; drape not seen.

Habitat: Dunedin, Water of Leith, Vauxhall, Saddle Hill, where it was first gathered by Mr. A. C. Purdie.

The species belongs to the group with fascicled female flowers, and is very distinct and well marked in its characters. It appears to be closely allied to another undescribed species growing near Dunedin, and forming a link between it and *C. rotundifolia.*

Art. LXIII.—*Description of a new Species of* Celmisia. By J. Buchanan. Plate XVIII.

[*Read before the Wellington Philosophical Society, 11th January,* 1879.]

Celmisia cordatifolia, n.s.

Leaves entire, with the petiole 6–8 inches long, 2 inches broad, obtuse or acute at tip, and cordate at the base, thickly covered below with rusty brown tomentum, glabrous and dull green above in old leaves, and in young leaves sprinkled with white silky hairs, which are more abundant at base and on midrib; petiole and petiolar sheath ribbed, covered and fringed with pale brown tomentum; inner surface glabrous, purple. Scape 10–12 inches high, with long linear bracts, the whole covered with rusty brown tomentum, which often disappears on the bracts after flowering, leaving terminal tufts. Head 1½ inches in diameter; involucral scales numerous, in two series, outer series with terminal tufts of rusty-brown tomentum; rays narrow, ¾ inch long; pappus ¼ inch long; achene large, glabrous.

Collected by Mr. A. McKay, January, 1879, on Mount Starvation, Nelson.

This species, in its general appearance, shows an evident relationship to *Celmisia traversii*, but the cordate leaves which present the first departure from the normal leaf-form of *Celmisia*, is thought sufficient to constitute a new species.

DESCRIPTION OF PLATE XVIII.

Plant two-thirds natural size; head past flowering.

1. Female floret of ray.
2. Hermaphrodite floret of disk, with achene and pappus.
3. Pappus hair more magnified.

Art. LXIV.—*Notice of a new Species of* Pomaderris (P. tainui.) By Dr. Hector.

[*Read before the Wellington Philosophical Society*, 11*th January*, 1879.]

The tree which I have to introduce to the Society was discovered during my recent visit to the Mokau district, under circumstances of some interest beyond the mere botanical importance of a new addition to the flora of the country. It is a very local plant, being confined to about an acre of ground on a spur of the low sandy hills that extend along the coast, between the Mokau and the Mohakatina rivers.

The peculiar habit of the tree first attracted my attention, having a resemblance to a clump of apple trees, so that at first glance I thought it to be an old orchard or cultivation. I afterwards was much interested in hearing from the natives that a peculiar tree was growing on the spot where their ancestors first camped when they abandoned the *Tainui* canoe, in which they came from Hawaiki, and that this tree had sprung from the rollers or skids and the green boughs that were brought as flooring to the great canoe. On my doubting this, they offered to take me to the place, and if I could not recognise the tree as being found elsewhere in New Zealand, they would consider it as proof that the tradition was correct.

To my surprise they took me to the clump of trees I had previously observed, and as it is certainly quite distinct from any plant hitherto described from New Zealand, the tradition receives a certain amount of confirmation; and I need hardly point out that if it were true, and we could hereafter determine the original habitat of this tree, it might give us a clue to the whereabouts of the mythical Hawaiki, or the place whence the Maori originally migrated to New Zealand.

CELMISIA CORDATIFOLIA, *n. s.*

The following description of this plant indicates it to be closely allied to *Pomaderris apetala*, Labill., which is a native of Australia and Tasmania; but as it differs in its growing to a much larger size—that species being a mere shrub like the kumera-hau (*P. elliptica*) of New Zealand, whereas the tree now described grows to a height of 20 feet, with large stems 5 or 6 inches in diameter—I have thought it better to distinguish it by a specific name, and have adopted that by which it is known to the Maoris.

Pomaderris tainui, n.s.

A small shrubby tree, 20 feet high, with numerous irregular branches; smooth brownish-grey bark; young branches and under side of leaves covered with white stellate tomentum; leaves 2 to 3 inches long, elliptic-oblong, obtuse at both ends, irregularly crenulate, glabrous and dark green on the upper surface, with distant stellate bases on young leaves, principal veins very prominent, buff-coloured. Flowers small in open thyrsoid panicles, leafy at the base, buds nearly globular; *calyx* about 1¼ lines long with stellate leaves, the tube being very short; *petals* 0; *anthers* tipped by a small gland; *styles* divided to the middle with club-shaped, almost capitate stigmas; *capsule* not seen.

Habitat: Sea Coast, south of Mokau River. In flower 5th Dec., 1878.

ART. LXV.—*A Description of two New Zealand Ferns, believed to be new to Science.* By W. COLENSO.

[Read before the Hawke Bay Philosophical Institute, 14th October, 1878.]

I. CYATHEA.

Cyathea polyneuron, sp. nov.

Trunk stout, 12–15 feet high (garden plant 12 years old, 6 feet high, 3 feet in circumference under bases of fronds, and 2–6 at one foot above ground), densely covered with long black hairs, and marked with scars of fallen fronds.

Fronds (garden plant), 10–12, ample, grass-green colour above, paler below, gracefully drooping, 10–12 feet long, 4 feet 6 inches broad (in middle), oblong-lanceolate, membranaceous when first expanded, afterwards sub-coriaceous, tripinnate, glabrous above, floccosely hairy and woolly on veins and veinlets below.

Stipes stout, 12–15 inches long, 8–9 inches in girth at base, muricated, of a dark mahogany colour below and light yellow-green above, regularly marked with a light-coloured straight yet broken line running on both sides

from pinna to pinna the whole length of the stipe and rachis, each mark or dash, 6–8 lines long, having an interval or break of 1–2 lines; densely covered with long brown shining linear *scales* 1½–2 inches long and nearly 1 line wide at the base, curved transparent acuminate and pointed, beautifully and regularly marked, with finely serrulate edges, and having beneath them a thick rough plush-like undergrowth of blackish-brown shining finely barbed or jagged hairs.

Rachis and *subrachis* muricate, also densely covered with a thick coating of short dark plush-like hairs, which easily rub off; above, together with the *costæ* and *costules* densely hirsute (dark) and woolly (light-coloured).

Pinnæ alternate, 23–26 jugate, oblong-lanceolate, petiolate, (central) 2 feet 6 inches long, 10–12 inches broad, 6–7 inches distant (lower 10 inches) on rachis.

Secondary divisions or *pinnules* alternate, 30–32 jugate, linear-oblong acuminate and sub-caudate, 5–6 inches long, 1–1½ inches broad, petiolate, pinnate, thickly covered below with jagged acuminate shining silky light-coloured *scales*, each being curiously sprinkled with very long dark-brown hairs.

Segments alternate, 30–32 jugate, close set, linear, sub-falcate, crenately-serrate, 9 lines long, 2–3 lines broad, widest at base, lowermost sub-pinnatifid petiolate and auricled downwards, barren ones broader, deeply serrate or sub-pinnatifid.

Veins very numerous, conspicuous and translucent, bi-pinnately branched; *venules* 10–12 in each lower lobe, and running quite out into the margin.

Sori numerous, crowded, 12–16 on a segment, one on each lobe; *involucre* globose, transparent green and hyaline at first, afterwards light-brown, splitting irregularly.

This tree-fern is a fine and graceful species; one that at first sight, and without examination, may be easily mistaken for *C. medullaris*, which it much resembles,—but differs from that species in its general hairiness and and woolliness, in its larger size of frond (breadth, etc.) and richer appearance, in its pleasing grass-green colour, its truly pinnate segments, its peculiar hairy scales and its numerous pinnate veins,—these last two marks being its specific characteristics, and its very numerous veins or venules in a lobe, the origin of its trivial name.

I have known this fern for some 10–12 years at least. In 1865–6 I found a young plant growing here on my ground (Scinde Island, Napier) among the common fern (*Pteris esculenta*), and removed it to my garden, where it has done exceedingly well, although last summer it suffered from the very long drought. At first, and for some years, I had supposed it to be *Cyathea medullaris*, but for the last four years, during which it has borne fruit abundantly, I have believed it to be a new and distinct species; having

also obtained specimens of similar plants from the eastern slopes of the Ruahine Mountain forests, as well as from smaller woods near the sea on the east coast.

In general appearance this species is by far the handsomest of our (known) New Zealand Tree-ferns, its ample fronds having much less rigidity than those of the other larger species. Of my garden-plant the fronds shoot early in spring, and grow remarkably fast, at the rate of about 4½ inches longitudinally per diem; the outer ones, however, die rather early in summer, owing, I believe, to the extreme dryness of the soil on the limestone hill where it is growing; and, in dying, their very large and thick stipes bend down abruptly at a few inches above their junction with the trunk, but not so as to bring the withered fronds near to the plant.

II. HYMENOPHYLLUM.

Hymenophyllum erecto-alatum, sp. nov.

Plant terrestrial, sarmentose; *rhizome* glabrous; *roots* and *rootlets* densely villous with long dark-brown hairs.

Frond membranous, bright grass-green colour, 3–4 inches long, 2–3 inches broad, mostly decurved or bent, somewhat ovate, tripennatifid; *main rachis*, and also *secondary rachises* winged throughout; *wings* very much crisped and narrowly undulated and vertical, situated nearer to the upper surface and so giving a sulcated appearance.

Stipes distant from each other on rhizome, cylindrical, stout, woody, wiry, irregular, bent and curved, 4–5 inches long, always longer than the frond, light coloured, slightly winged above, wings decreasing gradually downwards for 1–2 in.

Segments pinnatifid; *lobes* narrow, very close together, obtuse and entire.

Involucres on lateral segments, rather large, sub-orbicular, open, free, lips toothed; *sori* semi-exserted and coloured red.

This fern is naturally allied to *H. demissum* (although that is a very much larger species), but in several respects it differs from it,—not even belonging to the same (artificial) section; of which Sir J. Hooker says:—"Frond *pinnate* below, stipes *not* winged, rachis winged *above only*." (Handbook). In all which characters our fern widely differs; also, in its smaller size, colour, closeness of segments, involucres, clusters of sori, etc., etc. The peculiarity of its being almost vertically winged gives it a striking appearance, which, together with the bright light-green of its frond, and the red colour of its large clusters of prominent sori, catches the eye at first sight, in its fresh state. Fruitful fronds, however, are rather scarce.

Hab: Growing diffusely among roots of trees in dry forests near Norsewood (Forty-mile Bush), Hawke Bay, 1876; and again, 1878.

ART. LXVI.—*On the Occurrence of the Australian Genus* Poranthera *in New Zealand.* By T. F. CHEESEMAN, F.L.S.

[*Read before the Auckland Institute, 10th June, 1878.*]

A FEW months ago, while examining the vegetation of the upper part of the Maitai Valley, near Nelson, I observed in one or two localities a small Euphorbiaceous plant, which, on examination, proved to belong to the Australian genus *Poranthera*. On referring to Bentham's "Flora Australiensis," it became evident that *P. microphylla*, Brong., the most widely-diffused species of the genus, approached in most of its characters to my plant; but as it, with all the other species, was described by Mr. Bentham as having the leaves alternate, while my specimens all had opposite leaves, I concluded that I had before me a new species of the genus. My friend Baron Müeller, however, who has done me the favour of examining a series of specimens, informs me that although all writers describe the leaves of *Poranthera* as alternate, *P. microphylla* "has not rarely some, and very seldom all the leaves opposite," and that he can find no characters to distinguish the New Zealand plant from the Australian. In this opinion, after examining a number of Australian specimens kindly forwarded by Baron Müeller, I now concur. As some little interest is naturally attached to the addition of a new genns to the New Zealand flora, I subjoin the following short diagnosis:—

Poranthera microphylla, Brong. in Duperry Voy. Coq. Bot. 218, t. 50 B; Bentham, Flora Australiensis, VI., 56.

Perfectly glabrous; stems slender, branched, prostrate at the base, ascending towards the tips, 6–9 inches long; leaves opposite, or rarely the upper ones alternate, linear-obovate, obtuse, gradually narrowed into the rather long petiole, $\frac{1}{5}$ to $\frac{1}{2}$ inch long, margins usually slightly recurved. Inflorescence composed of terminal, short and dense bracteate racemes; bracts linear-subulate, lower ones longer than the flowers; flowers minute, white, monœcious. Male flowers: calyx divided into 5 segments; petals 5, minute, linear-subulate, each with a large green gland at its base; stamens 5; rudimentary ovary composed of three clavate bodies. Female flowers rather larger and on longer pedicels; calyx and petals the same as in the males; stamens 0; ovary depressed, 6-lobed, 3-celled, each cell with two ovules; capsule separating into three 2-valved cocci, the whole falling away from the persistent axis; seeds granulate.

Hab: Among clumps of *Pimelea gnidia* in the *Fagus* forest, Upper Maitai Valley, Nelson—J. Adams and T. F. Cheeseman. In Australia the species ranges from Port Darwin to the south of Tasmania.

Had my specimens been gathered near to cultivation, or had they been found associated with naturalised plants, the species might have been looked

at as an immigrant merely. As it is, the retired nature of the locality, and the absence of naturalized species, save one or two of early introduction and wide diffusion, are altogether against this view. I also searched in vain for the plant in the immediate vicinity of Nelson, where introduced species are so abundant. A further argument in favour of its being indigenous lies in the fact that in Australia opposite-leaved forms are decidedly rare, and would be by no means likely to be introduced.

The Maitai Valley appears to be well worthy of a careful exploration. Among the plants noticed were *Metrosideros colensoi*, *Myrtus ralphii*, *Myrsine montana*, and *Phyllocladus trichomanoides.* I have been unable to find any previous record of the occurrence of these species in the South Island. *Olearia forsteri* occurs in the lower part of the valley. *Pittosporum rigidum*, *Myrtus obcordata*, *Scutellaria novæ-zealandiæ*, *Pimelea gnidia*, are all not uncommon. Among ferns *Aspidium oculatum* and *Botrychium ternatum* var. *dissectum* deserve special mention.

ART. LXVII.—*Notice of the Occurrence of* Juncus tenuis, *Willd., in New Zealand.* By T. F. CHEESEMAN, F.L.S.

[*Read before the Auckland Institute, 7th October,* 1878.]

SINCE the publication of the "Handbook" several species of *Juncus* have been added to the New Zealand Flora—two of which, *J. glaucus*, L., and *J. lamprocarpus*, Ehr.—are well-known European plants. I have now to record the discovery of *Juncus tenuis,* Willd., also a common Central European and North American species. My specimens were collected in January, 1875, near Omano, about 25 miles above Kaihu, on the Northern Wairoa River. The plant was abundant in some marshy ground not far from the bank of the river; but curiously enough, during the hurried examination I was able to make of the Wairoa district, I did not observe it either higher up or lower down the river, although suitable localities are sufficiently abundant.

So many European plants are becoming naturalized in the colony that additional evidence will be required before *Juncus tenuis* can be included in the list of our indigenous species. It certainly seems improbable that a plant with such a wide range in the northern hemisphere should be found in New Zealand alone in the southern; but too much stress cannot be placed on this argument, as a precisely similar case exists in *Carex pyrenaica*, which no one doubts being a true native of New Zealand. It must be borne in mind that our plant is not a native of any part of the British Islands, from whence the majority of our naturalized species are derived; and the locality

in which it was found cannot be said to be one in which new introductions would be sought for, or even expected. In any case, whether native or naturalized, its occurrence in New Zealand is remarkable.

Juncus tenuis can be distinguished from any of the New Zealand species by its slender, wiry culms, 12–18 inches high, leafy at the base only; short, channelled, almost setaceous and flaccid leaves; open terminal panicles; and lanceolate acute perianth segments, which are one-third longer than the broadly ovoid obtuse capsules.

Art. LXVIII.—*Notice of the Occurrence of the Genus* Kyllinga *in New Zealand.* By T. F. Cheeseman, F.L.S.

[Read before the Auckland Institute, 18th November, 1878.]

Mr. Thos. Ball, of Mongonui, has kindly forwarded to me for determination some specimens of a sedge which I identify with *Kyllinga monocephala*, Rottb., a species of wide distribution in tropical regions, but not hitherto recorded from any part of New Zealand. Mr. Ball informs me that the plant is abundant in some marshy ground on the north side of Mongonui harbour, but has not been noticed by him elsewhere in the district. So far as I can judge from the information supplied to me, the plant appears to be truly indigenous; indeed, it is precisely one of those species which might naturally be expected to occur in the northern extremity of the island, not yet completely explored in a botanical point of view. Its existence there is quite in harmony with what we know of plant distribution in New Zealand, there being several tropical forms confined to the district between Whangaroa and the North Cape, as *Hibiscus diversifolius*, *Cassytha paniculata*, and *Ipomœa tuberculata*.

Kyllinga can be distinguished from the other genera of *Cyperaceæ* indigenous to New Zealand by the compressed one-flowered spikelets, densely clustered in globose, usually solitary heads, surrounded by a leafy involucre. The following description will enable the species to be recognised:—

Kyllinga monocephala, Rottb.

Rhizome creeping; culms erect, 8–12 inches high, leafy at the base only; leaves narrow linear, flat, scabrid towards the points; involucre 3–4-leaved, spreading. Heads solitary, globose, pale; spikelets compressed, 1-flowered; two lower glumes minute, two upper nearly equal, ovate-lanceolate, sharply keeled, mucronate, about 7-nerved; stamens 2; nut broadly ovate, finely punctate, much shorter than the glumes; style 2-fid.

K. monocephala has a wide range. It is found in the warmer parts of Australia, and is abundant in the Fiji, Tongan, Samoan, and Society Islands, and elewhere in Polynesia. It also ranges through tropical Asia and Africa, and probably through a considerable portion of America. I am not aware that it occurs in Europe,

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ART. LXIX.—*List of Plants collected in the District of Okarito, Westland.* By A. HAMILTON.

[*Read before the Wellington Philosophical Society, 11th January,* 1879.]

THE area over which the following plants were collected may be defined as lying between the Waitaki and the Waiho rivers, and extending back to the foot of the ranges. I much regret that I was unable to devote any time to the Alpine flora, the highest point on which I collected being a short distance up the Francis Joseph Glacier. Most of the specimens were collected on the shores of the lagoon, which extends from Commissioner's Point to the town of Okarito, and round which are found many plants of interest, many of them apparently very local. The only place where I found *Hymenophyllum minimum* was on the rocks round Commissioner's Point, and *H. armstrongii*, and *Lycopodium ramulosum* appeared confined to a small cluster of gullies at the back of the town. Ferns were most plentiful in the low damp bush at the head of lake Mapourika and on the line of the Okarito-Bowen Road, above the forks of the Okarito river, the most attractive being the magnificent *Leptopteris superba.* Although cattle have now been for some years in the bush, the general character of the vegetation is unaltered.

Mr. Kirk has very kindly identified my specimens, a list of which is subjoined, and I trust that at some future day it may be supplemented with a more complete one, as I was compelled to leave the best parts of the district unvisited. The collection was made in 1877.

RANUNCULACEÆ.

Clematis parviflora, A. Cunn., var. *trilobata*.
hexasepala, DC.
Ranunculus rivularis, Banks and Sol.
β. subfluitans
subscaposus, Hook. f.
hirtus, Banks and Sol.

CRUCIFERÆ.

Cardamine hirsuta, L.
Lepidium............ ?

VIOLARIEÆ.

Viola filicaulis, Hook. f.
Melicytus ramiflorus, Forst.

CARYOPHYLLACEÆ.

Spergularia rubra, Pers., var. *marina.*
* *Silene quinquevulnera*, L.
* *Cerastium viscosum*, L.
* *Polycarpon tetraphyllum*, L.

PORTULACEÆ.

Montia fontana, L.

MALVACEÆ.
Plagianthus betulinus, A. Cunn.
lyallii, Hook. f.

TILIACEÆ.
Elæocarpus hookerianus, Raoul.
Aristotelia colensoi, Hook. f.

GERANIACEÆ.
Oxalis corniculata, L.

OLACINEÆ.
Pennantia corymbosa, Forst.

CORIARIEÆ.
Coriaria thymifolia, Humb.
ruscifolia, L.

LEGUMINOSÆ.
* *Trifolium minus*, Sm.
Sophora tetraptera, Aiten.
Carmichelia odorata, Col.

ROSACEÆ.
Rubus australis, Forst.
Potentilla anserina, L.
Geum parviflorum, Cunn.
Acæna sanguisorbæ, Vahl.

SAXIFRAGEÆ.
Weinmannia racemosa, Forst.
Quintinia serrata, A. Cunn., var. β.

DROSERACEÆ.
Drosera binata, Labill.
spathulata, Labill.

HALORAGEÆ.
Haloragis depressa, Hook. f.
alata, Jacq.
micrantha, Br.
Myriophyllum variæfolium ? Hook. f.
pedunculatum, Hook. f.
elatinoides, Gaudich.
Gunnera monoica, Raoul.
densiflora, Hook. f.

MYRTACEÆ.
Leptospermum scoparium, Forst.
Metrosideros scandens, Banks and Sol.
lucida, Menzies
Myrtus pedunculata, Hook. f.

ONAGRARIEÆ.
Fuchsia excorticata, Lin. f.
Epilobium rotundifolium, Forst.
alsinoides, A. Cunn.
nummularifolium, A. Cunn.
melanocaulon, Hook.
pallidiflorum, Sol.

UMBELLIFERÆ.
Hydrocotyle moschata, Forst., var.—.
asiatica, L.
novæ-zealandiæ, DC., var.—.
Crantzia lineata, Nuttall.
Eryngium vesiculosum, Labill.
Angelica gingidium, Hook. f.
Apium filiforme, Hook.

ARALIACEÆ.
Panax simplex, Forst.
colensoi, Hook. f.
edgerleyi, Hook. f. (young)
crassifolium, Dcne and Planch.
sp.—(young state).

CORNEÆ.
Griselinia littoralis, Raoul.

RUBIACEÆ.
Coprosma fœtidissima, Forst.
robusta, Raoul.
tenuicaulis, Hook. f.
lucida, Forst.
parviflora, Hook. f.
Nertera depressa, Banks and Sol.
dichondræfolia, Hook. f.
Asperula perpusilla, Hook. f.

COMPOSITÆ.
Olearia ilicifolia, Hook.
virgata, Hook. f. (var.)
nitida, Hook. f.
Celmisia longifolia, Cass.
bellidioides, Hook. f.
Lagenophora forsteri, DC., et var.
Cotula coronopifolia, L.
perpusilla, Hook.
Craspedia fimbriata, DC.
Cassinia vauvilliersii, Hook. f.
Raoulia tenuicaulis, Hook. f.
Gnaphalium luteo-album, L.
involucratum, Forst.
bellidioides, Hook. f.
filicaule, Hook. f.
Senecio lautus, Forst.
Taraxacum dens-leonis, Desf.

CAMPANULACEÆ.
Wahlenbergia saxicola, A. DC.
Lobelia anceps, Thunberg.
Pratia angulata, Hook. f.
Selliera radicans, Cav.

ERICEÆ.
Gaultheria antipoda, Forst., v.

ERICEÆ.—*continued.*
Cyathodes acerosa, Br.
Leucopogon fraseri, A. Cunn.

PRIMULACEÆ.
Samolus repens, Pers.
* *Anagallis arvensis*, L.

APOCYNEÆ.
Parsonsia rosca, Raoul.
albiflora, Raoul.

CONVOLVULACEÆ.
Convolvulus tuguriorum, Forst.
sepium, Linn.
Cuscuta densiflora, Hook. f.

SOLANEÆ.
Solanum aviculare, Forst.

SCROPHULARINEÆ.
Glossostigma elatinoides, Benth.?
A doubtful identification in the absence of flowers or fruit.
Veronica lyalli, Hook f.
linifolia, Hook. f.
lævis, Benth.
Mimulus repens, Br.
Euphrasia revoluta, Hook. f.

LENTIBULARIEÆ.
Utricularia monanthos, Hook. f.

VERBENACEÆ.
Myoporum lætum, Forst.

LABIATEÆ.
Mentha cunninghamii, Benth.

PARONYCHIEÆ.
Scleranthus biflorus, Hook. f.

POLYGONEÆ.
Muhlenbeckia complexa, Meisn.
adpressa, Lab.
Rumex acetosella, L.

LAURINEÆ.
Hedycarya dentata, Forst.

THYMELEÆ.
Pimelea prostrata, Vahl.

CUPULIFERÆ.
Fagus fusca, Hook. f.
solandri, Hook. f.

PIPERACEÆ.
Piper excelsum, Forst.

CONIFERÆ.
Podocarpus totara, A. Cunn.
Dacrydium cupressinum, Sol.
Phyllocladus alpinus, Hook. f.

ORCHIDEÆ.
Earina autumnalis, Hook. f.
Dendrobium cunninghami, Lindl.
Bolbophyllum pygmæum, Lindl.
Corysanthes rivularis, Hook. f.
oblonga, Hook. f.
Microtis porrifolia, Spreng.
Prasophyllum nudum, Hook. f.
Pterostylis banksii, Br.
Spiranthes australis, Lindl.
Thelymitra pulchella, Hook. f.

IRIDEÆ.
Libertia micrantha, A. Cunn.

PANDANEÆ.
Freycinetia banksii, A. Cunn.

NAIADEÆ.
Triglochin triandrum, Mich.
Ruppia maritima, Linn.
Zostera nana, Roth., var. *müelleri*

LILIACEÆ.
Rhipogonum scandens, Forst.
Callixene parviflora, Hook. f.
Cordyline banksii, Hook. f.
Dianella intermedia, Endl.
Astelia grandis, Hook. f.
cunninghami, Hook. f.
Anthericum hookeri, Colenso.
Phormium tenax, Forst.
colensoi, Hook. f.

JUNCEÆ.
Juncus bufonius, L.
planifolius, Br.
Luzula campestris, DC.

RESTIACEÆ.
Calorophus elongata, Lab.

CYPERACEÆ.
Cyperus ustulatus, A. Rich.
Schænus axillaris, Hook. f.
pauciflorus, Hook. f.
Scirpus triqueter, L.
lacustris, L.
Eleocharis acuta, Br., var. *platylepis*
sphacelata, Br.
Isolepis prolifer, Br.
riparia, Br.
aucklandica, Hook. f.
fluitans, Br.
Desmoschænus spiralis, Hook. f.
Cladium gunnii, Hook. f.
Lepidosperma tetragona, Labill.
Uncinia cæspitosa, Boott.

Cyperaceæ.—*continued.*

Uncinia australis, Persoon.
compacta, Br., var. *divaricata*
banksii, Boott.
Carex subdola, Boott.
cataractæ, Br.
pumila, Thunb.
ternaria, Forst.
lucida, Boott.
gaudichaudiana, Kunth. (small state)
lambertiana, Boott.
sp. allied to *C. testacea*, Sol.
sp. nov.

Gramineæ.

Zoysia pungens, Willd.
Dichelachne crinita, Hook. f.
Agrostis æmula, Br.
quadriseta, Br.
Danthonia cunninghami, Hook. f.
semi-annularis, Br.
,, var. *β. pilosa*
Deschampsia cæspitosa, Palisot.
Hierochloe redolens, Br.
alpina, Rœm. and Sch.
Poa breviglumis, Hook. f.
anceps, Forst.
,, var. *β. foliosa*
australis, var. *lævis*, Br.
foliosa, Hook. f.
colensoi, Hook. f.
Festuca duriuscula, L.
**Briza minor*, L.
**Holcus lanatus*, L.
**Poa annua*, L.
* *pratense*, L.
**Bromus mollis*, L.
**Festuca myurus*, L.
**Anthoxanthum odoratum*, L.
**Dactylis glomerata*, L.
**Lolium perenne*, L.
* *temulentum*, L.

Filices.

Gleichenia circinata, Swartz.
cunninghamii, Heward.
Cyathea dealbata, Swartz.
Hemitelia smithii, Hook.
Dicksonia lanata, Col.
Hymenophyllum tunbridgense, Sm.
,, var. *β. cupressiforme*
unilaterale, Willd.
minimum, A. Rich.
cheesemannii, Baker.
armstrongii, Kirk.

Filices.—*continued.*

Hymenophyllum rarum, Br.
pulcherrimum, Col.
dilatatum, Swartz.
polyanthos, Swartz.
villosum, Colenso.
demissum, Swartz.
scabrum, A. Rich.
flabellatum, Labill.
æruginosum, Carmich.
rufescens, Kirk, MS.
Trichomanes reniforme, Forst.
strictum, Menzies.
colensoi, Hook.
venosum, Br.
lyallii, Hook.
Davallia novæ-zealandiæ, Col.
Lindsæa trichomanoides, Dryand.
Pteris incisa, Thunb.
scaberula, A. Rich.
aquilina, L., var. *esculenta*
Lomaria nigra, Col.
alpina, Spreng.
procera, Spreng.
,, var. *minor*.
fluviatilis, Spreng.
discolor, Willd.
lanceolata, Spreng.
elongata, Blume.
vulcanica, Blume.
Asplenium obtusatum, Forst.
lucidum, Forst.
falcatum, Lam.
bulbiferum, Forst.
flaccidum, Forst.
Aspidium aculeatum, Swartz.
,, var. *vestitum*, Hook.
capense, Willd.
Nephrodium glabellum, Cunn.
Polypodium australe, Mett.
grammitidis, Br.
rugulosum, Labill.
pennigerum, Forst.
serpens, Niph.
billardieri, Br.
Leptopteris superba, Hook. f.
Ophioglossum costatum, Br.

Lycopodiaceæ.

Lycopodium billardieri, Spreng.
ramulosum, Kirk, MS.
magellanicum.
scariosum, Forst.
laterale, Br.
Tmesipteris forsteri, Endl.

Marsileaceæ.

Art. LXX.—*Notes on Mr. Hamilton's Collection of Okarito Plants.* By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 10th January,* 1879.]

During a few months' residence in Okarito, Mr. Hamilton made a collection of plants found in the immediate vicinity, and kindly placed it at my disposal for examination. The results show that his work is of great value, not only throwing light upon the botany of a district of which previously we were entirely ignorant, and adding one or two species to our flora, but especially in extending our knowledge of the geographical distribution of certain local species, and clearing up doubts entertained with regard to others. I gladly comply with his request to summarize the chief points of interest brought out by his labours, in order that they may accompany the useful catalogue of Okarito plants, which he has prepared for publication in our Transactions.*

Mr. Hamilton informs me that the collection consists entirely of lowland plants, none of the specimens having been obtained at a greater altitude than 1,000 feet. In addition to alpine plants, many lowland species of general distribution are omitted from the collection; amongst these are *Podocarpus dacrydioides*, *P. ferruginea*, *P. spicata*, *Olearia cunninghamii*, *Convolvolus soldanella*, *C. sepium*, *Panax arboreum*, *Elæocarpus dentatus*, *E. tetragonum*, *Epilobium pubens*, *Ranunculus acaulis*, and other common lowland forms; also such forms as *Dacrydium colensoi*, *Libocedrus bidwillii*, and others of a subalpine character, which doubtless attain their lowest limit in the district at or below one thousand feet. Amongst genera not represented in the collection are *Pittosporum*, *Colobanthus*, *Geranium*, *Aciphylla*, *Schefflera*, *Erechtites*, *Dracophyllum*, *Rumex*, *Chenopodium*, *Atherosperma*, *Potamogeton*, *Gahnia*, *Triticum*, and *Echinopogon*, all of which must occur in the district, although at present they have not been collected, while many large genera, as *Ranunculus*, *Carmichælia*, *Epilobium*, *Coprosma*, *Olearia*, *Cotula*, *Pimelea*, *Juncus*, are represented by not more than from one to three species. At present, therefore, no conclusions based upon the apparent absence of certain species would be trustworthy, and I can do little more than point out the most remarkable species, and indicate the additions made to our knowledge of the geographical distribution of others.

Alectryon excelsum, DCand., and *Quintinia serrata*, Cunn., both of which may be expected to find their southern limit at or near Okarito, are not represented in Mr. Hamilton's collection.

Lepidium, sp.

A fragment of an erect plant belonging to this genus is in the collection. The branches are long and somewhat spreading; leaves half inch long,

* *Vide* Art. LXIX.

sessile, toothed; flowers in terminal racemes. The specimen is in an immature fruited condition. The habit of the plant is exactly that of *Camelina dentata*, Pers., which it closely resembles in general appearance.

Viola filicaulis, Hook. f.

Mr. Hamilton points out that the flowers are sometimes produced in pairs from the same axil.

Panax simplex, Forst.

A small specimen, not more than 3 inches in height, is doubtfully identified with the young state of this species. It has 5-foliolate, membranous leaves, with long slender petioles, and pinnate or pinnatifid leaflets; the segments sharply toothed.

Panax, sp. nov.?

Two specimens in the young state, 6–8 inches in height, appear widely different from any described New Zealand species. They are characterised by simple linear leaves, similar to those of *P. crassifolium*, but membranous, narrow, and not more than from 3 to 5 inches long, on slender petioles, with sharp distant teeth. One specimen has at the base deeply tripartite leaves, the middle segment being much the longest. The lowest leaf is trilobate, with short broad teeth, so that it closely resembles the leaf of the hawthorn.

Celmisia bellidioides, Hook. f.

Mr. Hamilton does not mention the precise locality where he collected this plant, probably in the vicinity of the lower part of the Francis Joseph Glacier, which would explain its occurrence at so low an elevation as 1,000 feet or less.

Cuscuta densiflora, Hook. f.

The discovery of this remarkably local plant at Okarito shows a marked extension of its western range. Elsewhere it occurs in Nelson, Port Underwood, and Otago, but appears to be confined to a single locality in each district.

Euphrasia revoluta, Hook. f.

Not previously observed at so low an altitude as 1,000 feet; the remarks respecting *Celmisia bellidioides* apply to this plant also.

Euphrasia longiflora, MS.

I apply this name provisionally to a remarkable plant of which Mr. Hamilton's specimens are scarcely sufficient to enable me to offer a complete description. It will be seen that in some respects it differs from *Euphrasia*, although perhaps not to a sufficient degree to warrant generic distinction.

Stems weak, procumbent, matted, tetragonous, 2–4 inches long, and with the leaves sparingly covered with scattered retrorse hairs; leaves

opposite or verticillate, quite entire, $\frac{1}{6}$–$\frac{1}{4}$ inch long, shortly petioled or sessile, lanceolate, acuminate, 3-nerved. Flowers on short curved peduncles, solitary, axillary, erect, calyx 4-toothed; corolla tube narrow, greatly elongated, $\frac{1}{2}$–$\frac{3}{4}$ inch long, tip short, broad, bifid, projecting; capsules oblong, slightly beaked, ovules solitary.

This plant differs from all other *Euphrasiæ* in the entire leaves, greatly elongated corolla tube, and solitary ovules. A further supply of specimens is desirable in order to establish the permanence of the last character.

Spiranthes australis, Lindl.

The Okarito specimens of this local plant mark a considerable extension of its western range. Specimens mixed with *Microtis porrifolia*, apparently collected on Banks' Peninsula some years back by Mr. Armstrong, junr., are in the herbarium of the Christchurch Museum; the credit of its first discovery in the South Island is therefore due to that gentleman.

The other known localities for this species in New Zealand are Waikato, where it was originally discovered by Mr. Colenso; St. John's Lake, Auckland, whence I have a fine specimen collected by Mr. Cheeseman; and Kaitoke swamps on the Great Barrier Island, where I had the pleasure of collecting it some years past.

Zostera nana, Roth., var. *müelleri.*

This discovery marks a great extension of the southern range of our plant, and is the first instance of its having been observed in the South Island.

Ruppia maritima, L.

Two forms of this plant are represented, one with narrow slender sheaths, and elongated spirally coiled peduncles; the other is a more robust plant with much broader sheaths, and may be *R. rostellata*, Koch, but the specimens are not in flower or fruit.

Astelia cunninghamii, Hook. f.

The Okarito habitat for this species shows a marked extension of its southern range.

Areca sapida, L.

Mr. Hamilton informed me that the occurrence of one or more specimens of the nikau in the vicinity of Okarito is commonly asserted, but although he made enquiries from the diggers, he failed to find it, nor did he meet with anyone who had actually seen the palm growing in the district. I was assured that on the opening of the goldfield at Ross, the nikau occurred sparingly, but was soon destroyed; the most southern habitat known to me on the West Coast is between Greymouth and Hokitika, in latitude 42° 30′. On the East Coast it is said to occur on Banks' Peninsula; I did not observe it at Akaroa, but have no reason to doubt its occurrence on the

north side of the peninsula, which would fix its extreme southern limit, on the main land, in latitude 43° 40′ S; and it is found on the Chatham Islands in latitude 43° 46′ S. The latitude of Nice, the extreme limit of the northern palm, *Chamærops humilis*, is 43° 44′ N, so that the actual limits of palms in the northern and southern hemispheres are identical, instead of exhibiting a difference of five or six degrees, as stated in our botanical text books.

Eleocharis sphacelata, Br.

The discovery of this plant on the West Coast of the South Island renders its occurrence on Bluff Island more probable than I have hitherto deemed it.* Its apparent absence from the extensive district between the Taupo country and Okarito is most remarkable.

Isolepis fluitans, Link.

The identification of the Bluff plant referred to this species being doubtful, owing to the imperfect condition of the specimens, its occurrence at Okarito is of some interest, as showing the most southern station at present known.

Carex, sp.

Three small specimens of a form differing from any other described New Zealand species were picked from amongst grass; although in an imperfect condition, they may be thus characterized:—

Tufted; leaves almost filiform, keeled, erect; culms 2 to 3 inches high, equalling or shorter than the leaves; the lowest bract overlapping the culms. Spikelets 2–3, the uppermost male; female 3–5-flowered; glumes ovate-acuminate with a stout nerve; stigmas 2; utricle ——?

Carex, sp.

A doubtful plant, probably not uncommon in both islands; presents rather close affinities with *C. testacea*, but differs in the broader, spreading leaves, more slender culms, and in having all the spikelets, except the uppermost, on slender peduncles.

Zoysia pungens, Willd.

Okarito is the only locality at present known for this grass on the West Coast of the South Island. It will probably be found to attain its extreme southern limit on the West Coast, possibly at or near to Jackson's Bay.

Cyathea dealbata, Swartz.

This species becomes very local on the West Coast, south of Greymouth, being absent from extensive areas. Its place is occupied by *Hemitelia smithii*. Mr. Hamilton gives no information as to its occurrence at Okarito.

Hymenophyllum minimum, Swartz.

This species evinces a decided partiality for shaded rocks near the sea. It is easily distinguished from its New Zealand congeners by the solitary

* See Transactions N.Z. Inst., Vol. X., p. 412.

receptacle terminating the rachis, and by its pale green colour. In the North Island it appears to be confined to the vicinity of Cook Strait.

Hymenophyllum cheesemanni, Baker.

Mr. Hamilton is the first discoverer of this plant in the South Island. Recently it has been collected near Hokitika by Mr. Tipler.

Hymenophyllum armstrongii, Kirk.

This shows a considerable extension of its southern range. Mr. Hamilton's specimens suggest the great probability of the identity of this and the preceding species, as many fronds are entirely destitute of the stout marginal nerve which forms the only prominent distinction between the two. The same rhizome sometimes exhibits fronds with the marginal nerve, arrested at different stages of development, from the typical condition of *H. armstrongii*, in which the marginal nerve is fully developed, to that of *H. cheesemanni*, in which it is entirely wanting. The marginal nerve may even be developed on one side of a segment, as in *H. armstrongii*, while the other side exhibits no trace of it, as in *H. cheesemanni*. Not unfrequently it is reduced to a slight thickening at the base of each tooth. At present I am unable to satisfy myself whether its absence must be considered due to simple non-development or to absorption.

Hymenophyllum villosum, Colenso.

This habitat is at a lower altitude than is usually affected by the species, although I am not certain that it is the lowest yet observed.

Hymenophyllum pulcherrimum, Col.

Mr. Hamilton's specimens are the finest I have seen, some of them being twenty-seven inches long, but remarkably narrow in proportion.

Hymenophyllum rufescens, n.s.

At present only known from this locality and from another in the North Island. See Art. LXXIV.

Davallia novæ-zealandiæ, Col.

The fronds of this plant also are of unusual luxuriance, a solitary pair of pinnæ in the collection, measuring nineteen inches from tip to tip.

Lomaria, sp.

Two fragments of a plant which may be *Lomaria attenuata*, Willd., are comprised in the collection. They are about four or five inches in length; one specimen is the acute apex of a barren frond, the lowest segments of which are apparently pinnate, with an acute narrow sinus, and attached by very broad bases; segments acute, margins uneven. The other specimen is the basal portion of a fertile frond, pinnules sessile, 1½ inch long, with broad bases, acuminate, the two lowest deflexed. The specimens are too imperfect to admit of positive identification, but the plant certainly differs from all described New Zealand forms.

Polypodium grammitidis, Br.

On the West Coast of the South Island this plant exhibits a greater range of variation than usual. Mature sporiferous specimens collected by Mr. J. D. Enys are from 2 to 3 inches long, and not more than ¼ inch wide. The lower portion is cut into deltoid pinnules or lobes ⅛ of an inch long; the upper part is deeply toothed. In this state it closely resembles the Cingalese *P. cucullatum*, Nees, but the pinnules are broader at the base. Some of Mr. Hamilton's Okarito specimens have the pinnules lobed and worked to an excessive degree, in others the fronds are 8 to 10 inches long, pinnatifid, with simple entire pinnules. In others again the frond is similar, but the pinnules are slightly toothed. When in this state I am unable to distinguish this plant from *P. subfalcatum*, Blume, of the Malay Archipelago.

Lycopodium ramulosum, Blume.

Only known at present from this locality, and the vicinity of Hokitika. See Art. LXXIII.

P.S.—Since the above was written, Mr. Hamilton has informed me that *Celmisia bellidioides* and *Euphrasia revoluta* were collected near the face of the glacier, at an elevation of between 700 and 800 feet.

Art. LXXI.—*Notes on the Botany of Waiheke, Rangitoto, and other Islands in the Hauraki Gulf.* By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 28th September*, 1878.]

In few localities is the importance of atmospheric moisture, as a factor in the distribution of vegetable life, more forcibly demonstrated than amongst the small islands in the lower part of the Hauraki Gulf. Most of these islands consist of sandstones, clays, and slates, and are watered by springs and small streams. In every case the islands of this class exhibit a luxuriant vegetation, more or less copious in the number of species, according to the variety of soil, situation, and aspect. One or two of the smaller islands are composed of basaltic scoria, and are entirely destitute of water, except such as may be collected in rock-cavities during rainy weather, and are therefore entirely dependent upon atmospheric moisture for the maintenance of vegetable life. While both classes exhibit marked peculiarities in their botanical features, the most striking are those to be seen on islands of the latter class, destitute alike of surface soil and a perennial water supply.

In this paper I purpose to offer a brief account of the chief characteristics of the vegetation of these islands, and to draw attention to those features which have been most strongly developed by their respective physical peculiarities.

The largest island of the group is Waiheke, about thirteen miles in length, with a mean breadth of three and a-half miles, although in some places much wider. It is estimated to comprise 23,200 acres, of which 1,500 are laid down in grass. It consists chiefly of stiff clays, sandstones, and slates, and in its altitude and general characteristics bears considerable resemblance to the island of Kawau. The hills are low, nowhere exceeding 750 feet in altitude, the valleys are chiefly of an open character, and there are few deep ravines; most of the coast line is rocky; in fact, there are only one or two short pieces of sandy beach on the entire coast, and there are no extensive swamps. Manganese crops out on the surface in several localities, and is now worked in one or two places, forming an article of export. At the present time, partly from actual clearing of forest land and laying down in grass, and partly from the destruction effected by the constant browsing of cattle, coupled with frequent burning of the fern and manuka in the open country, the relative proportion between different species has become greatly altered, but there is no reason to suppose that even a single species has been extirpated.

The forest vegetation is usually of considerable luxuriance, although, as a rule, not remarkable for timber of large dimensions; to this however there are some notable exceptions. The kauri *(Dammara australis)* was formerly plentiful in several localities, but has become extremely rare; as on the Great Barrier Island, so on Waiheke, it specially affected soils derived from the older rocks. The tooth-leaved beech *(Fagus fusca)* occurs in considerable quantity at the sea level, occasionally of large size; the rimu *(Dacrydium cupressinum)* also frequently attains large dimensions, but the totara (*Podocarpus totara*) is rare and always small; the maire (*P. ferruginea*) is rather more plentiful, and the matai *(P. spicata)* decidedly rare; I did not observe a single specimen of large size. The tawa *(Nesodaphne tawa)* forms a large portion of the forest in many places, while the taraire *(N. taraire)* is comparatively rare; the pukatea *(Atherosperma novæ-zealandiæ)*, white pine *(Podocarpus dacrydioides)*, and tanekaha *(Phyllocladus trichomanoides)* are not infrequent; puriri *(Vitex littoralis)*, rata *(Metrosideros robusta)*, hinau *(Eleocarpus dentatus)*, kowhai *(Sophora tetraptera)*, mangiao *(Tetranthera calicaris)*, kohe-kohe *(Dysoxylum spectabile)*, titoki *(Alectryon excelsum)*, toro *(Persoonia toro)*, tipau *(Myrsine salicina)*, mapau *(M. australis)*, and others affording useful woods are found in most forest districts, although nowhere abundant. One of the most strongly marked

features in the sylvestral vegetation was the occurrence of large tracts of tea-tree forest *(Leptospermum ericoides)*, these were so extensive and afforded such excellent firewood that for many years the chief portion of the Auckland firewood supply was derived from Waiheke. It is said that in addition to the supply from land in the possession of settlers, Government reserves wers illegally denuded of thousands of tons by squatters, who considered it a violation of first principles to pay any thing in the shape of royalty, or acknowledge the authority of a government that did not consider the assertion of its rights a matter of importance. The value of this tree for small piles and for fencing purposes tended largely to accelerate its destruction, so that notwithstanding its former abundance there is now very little to be seen in the island, and the trivial amount of firewood still exported is of inferior quality.

Amongst the ornamental trees and shrubs which abound on the island are *Quintinia serrata*, with its handsome peach-coloured blossom, *Weinmannia silvicola*, the flowers of which are much more showy than those of its southern ally, the ngaio, (*Myoporum lætum*), *Fuchsia excorticata*, *Olearia cunninghamii* with its numerous corymbs of white flowers so well known throughout the colony; and *O. furfuracea* restricted to the north; *Carmichælia australis*, *Metrosideros florida*, *Clematis indivisa*, and many other species characteristic of the Northern forest. Two plants, however, require special notice. *Coprosma arborea*, the largest species of the genus, forms a considerable proportion of the less luxuriant forest growth in several localities, but as the wood of this tree gives off an unpleasant odour when burning, it is usually left standing by the firewood cutters, although occasionally sought after by the inlayer on account of its peculiar yellow colour. *Alseuosmia macrophylla*, so characteristic of the undergrowth of the Northern forest generally, is abundant in some parts of the island, its pendulous crimson flowers diffusing their grateful perfume over a considerable area. The so-called kauri grass *(Astelia trinervia)*, is abundant in several of the forest districts.

On the cliffs, and on the margin of forests by the sea, the splendid pohutukawa (*Metrosideros tomentosa*) attains a large size and is still plentiful, although often recklessly destroyed. *Sapota costata* occurs in a few sheltered bays, but it is rarely of large size, *Pittosporum crassifolium* is occasionally seen, but only near the beach; *Hymenanthera tasmanica* was observed on the Onitangi sands, and most of the ordinary maritime plants may be found by careful search.

The open ground is covered with fern *(Pteris esculenta)* or with scrubby manuka (*Leptospermum scoparium*), intermixed with a sparse growth of dwarf shrubs, grasses and other herbaceous plants: amongst the former, *Poma-*

derris phylicifolia is, perhaps, the most abundant; *Dracophyllum squarrosum*, *Leucopogon fasciculatum*, *L. frazeri*, *Cyathodes acerosa*, *Gaultheria antipoda*, *Coriaria ruscifolia*, *etc.*, are common. The more frequent grasses and herbaceous plants are *Sporobolus elongatus*, *Agrostis æmula*, *A. quadriseta*, *Triticum multiflorum*, *Poa anceps*, *Dichelachne crinita*, *Microlæna stipoides*. *Glyceria stricta* was collected in a single locality on the coast. *Geranium molle*, *G. microphyllum*, *G. dissectum*, *Oxalis corniculata*, *Pelargonium clandestinum*, *Acæna sanguisorbæ*, *Haloragis alata*, *H. diffusa*, *Epilobium pubens*, *E. junceum*, *E. rotundifolium*, *E. nummularifolium*, *Daucus brachiatus*, *Gnaphalium collinum*, *G. luteo-album*, *G. involucratum*, *Wahlenbergia gracilis*, etc., etc. In most places *Cladium sinclairii*, *C. gunnii*, *Schænus tendo*, *S. tenax*, etc., with a few orchids, of which the most frequent were *Microtis porrifolia*, *Thelymitra longifolia*, and *Orthoceras solandri*. *Phormium tenax*, with several species of *Juncus*, *Carex*, *Gahnia* and other sedges, occurred in marshy places, especially on the borders of forests, but, as a rule, paludal plants were poorly represented.

Arborescent ferns are represented by *Cyathea medullaris*, *C. dealbata*, *Dicksonia squarrosa*, and very rarely by *Hemitelia smithii*; none of the rarer kinds were observed. The ferns and allied plants generally were remarkably few in number; besides the tree ferns, the most striking are *Lomaria fraseri*, and *Lygodium articulatum*.

I have already mentioned the general resemblance between the chief physical features of the Kawau and Waiheke. Although the total number of ferns on the latter island is greatly below that of the Kawau, the resemblance between the Phænogamic portion of the flora* of both is remarkably close. I can only enumerate three plants as occurring on Waiheke, which are not also found on Kawau: they are *Hymenanthera tasmanica*, *Pimelea arenaria*, and *Melicytus micranthus*; the first and second of these are extremely rare, the third occurs in several localities, and in all probability is to be found on Kawau, although not observed either by Mr. Buchanan or myself.

The kauri and tooth-leaved beech, both of which are rare on Kawau, occur or rather have occurred on Waiheke in considerable quantity. *Coprosma arborea* is also more plentiful on the latter island than the former, and the same remark applies to *Metrosideros robusta*, of which only a single specimen is known in Kawau. The large tea-tree, although plentiful on that island, never occurred in such great abundance as on Waiheke. On the other hand, one of the most characteristic plants of the Kawau flora,

* Of course excluding numerous species, such as *Gnaphalium filicaule*, *Juncus novæ-zealandiæ*, *Uncinia rubra*, *Eryngium vesiculosum*, etc., etc., erroneously recorded as indigenous on Kawau. See Trans. N.Z. Inst., IX., pp. 525–527.

Cordyline pumilio, is extremely rare on Waiheke. *Sapota costata* attains its greatest dimensions on Kawau, but is small on Waiheke; while *Pittosporum tenuifolium*, *P. crassifolium*, and other species are not nearly so frequent on Waiheke as on Kawau.

Waiheke may be considered to possess a moderately copious flora, exhibiting a great amount of luxuriance and vigour, although its most important species are far from attaining extreme dimensions, the greatest amount of variety as well as the most luxuriant growth being found in the deeper portions of the forest, or in sheltered bays by the sea. The least amount of variety is found on the open fern or tea-tree lands on the higher parts of the island.

The other islands are of smaller size than Waiheke, the largest not comprising more than one-fourth of the acreage of that island. Ponui contains 4,726 acres, and presents similar geological features; its flora is less copious than that of Waiheke, its most noticeable feature being the abundance of *Brachyglottis* and other low-growing shrubs.

Motutapu has an area of 3,728 acres, more than half of which is laid down in excellent grass, most of the remainder being manuka or open fern land; yet, notwithstanding the unfavourable conditions which exist upon this little island, upwards of two hundred and forty species of phænogams and ferns were catalogued; about forty-five of these were naturalized plants, chiefly of agricultural introduction, the most noteworthy being *Myosotis collina*, Hoffm., which has not been observed elsewhere in the colony, so far as I am aware. Nothing in the shape of arboreal vegetation is to be found, except in sloping places on the cliffs, and in one or two bays, where magnificent specimens of the pohutukawa are still to be seen, rarely associated with *Sapota costata* and *Corynocarpus lævigata*. Ferns are extremely rare, and the bulk of the native vegetation is either littoral or ericetal in its character. Two native grasses, *Trisetum antarcticum* and *Triticum multiflorum*, are more plentiful than in other parts of the Auckland district. Motutapu consists of sandstones and clays, the former sometimes so regularly stratified as to present an artificial appearance.

Motuihi contains about 460 acres, more than half of which is pasturage. The open, uncleared portion is chiefly covered with manuka or fern, and patches of large arboreal vegetation are to be found on the slopes, the most important member being the pohutukawa, which attains large dimensions. On a charming miniature sandy beach, *Dichelachne stipoides*, *Pimelea arenaria*, *Paspalum distichum*, and *Sicyos angulatus* are plentiful. The last-named has not been observed on any other of these islands.

Of the vegetation of Little Motutapu (Rukino), containing only 450 acres, and of Pakihi, containing 280 acres, nothing is known.

Te Ratoroa contains 204 acres. Its flora is chiefly remarkable for the profusion of *Entelea*, associated with *Brachyglottis*, *Coprosma*, *Veronica*, and other small shrubs. The plants of Motuora are of a similar character.

Motukorea, or Brown's Island, has an area of 150 acres. It is chiefly volcanic, and contains one of the most perfect craters to be found in the Auckland system. With the exception of the lava field, which forms a large portion of the lower part of the island, the whole has been laid down in grass, and presents no botanical features of special interest. In a few places, where water accumulates in spaces amongst the blocks of lava, or percolates through them from the sea, *Typha latifolia*, *Scirpus maritimus*, and other uliginal plants are found in some quantity. In other parts of the lava field a dense growth of bushy shrubs attracts attention. *Olearia furfuracea* and *Metrosideros tomentosa* occur sparingly, but the latter is usually of small size.

The volcanic island of Rangitoto, which forms so prominent a feature in the scenery of the Hauraki Gulf, possesses greater interest to the botanist than any other island in the group. This arises less from a copious flora-although the number of species is comparatively large—than from the remarkable state of the ligneous vegetation, which exhibits the utmost luxuriance of foliage and flowers on the most diminutive specimens, and from the peculiar conditions of growth, most of the plants springing directly from the face of the rocks or from the crevices between them. A brief description of the island will enable us better to understand the peculiarities presented by its flora.

Rangitoto is roughly circular in outline, with deep indentations; its greatest diameter is about four miles; its least two and a-half miles; it is estimated to contain 5,644 acres, and is next in size to Waiheke. Its base consists of an irregular lava field, rising towards the centre at an angle of four or five degrees. From near the centre the scoria cone, which forms the crater, rises at an angle of about 35 degrees to the height of 930 feet. The cone is double, but the outer one has been carried away in places; the inner and more elevated cone forms the largest and best preserved crater to be found in the Auckland system. It is considered to be the latest manifestation of volcanic activity in the Waitemata district. Although only 200 feet higher than the highest point of Waiheke, its isolated peak is frequently surrounded by clouds, while the whole of the adjacent isthmus is suffering from want of rain.

The lava field, which forms the chief portion of the island, is extremely rough and difficult of examination, being broken up into chasms, ravines, and irregular depressions; for the most part progress can only be made by leaping from one sharp-edged block of scoria to another, or by scrambling

up one side of a ridge to descend on the other. The central cone, which forms but a small part of the whole, consists of loose cinders and ashes, into which the feet sink at every step of the ascent. The island may therefore be regarded as a huge filter, through which the rain percolates, so that a perennial stream or even a spring is an impossibility; in fact, the island is entirely destitute of water, except the small quantity that during rainy weather accumulates in rock-cavities, and which is speedily evaporated. The formation of surface soil is impossible under such conditions, since the comminuted particles of rock or ash are washed into the interstices of the rocks by every shower, or blown away by every breeze.

Yet under these antagonistic conditions, less favourable on the whole to vegetable life than even the pumice-covered plains of the Taupo district, we find a flora comprising fully one-seventh of the entire number of flowering plants and ferns indigenous to the colony always exhibiting extreme luxuriance of foliage, although its larger members are greatly dwarfed in stature, and at certain periods of the year presenting an amount of floral splendour which finds no counterpart in the southern portions of the colony.

In many places the chasms and depressions are occupied by a most luxuriant growth of Mosses, Hepaticæ, and Lichens, the most frequent of which are *Hypnum furfurosum*, *Chandonanthus squarrosus*, *Polyotus claviger*, *Trichocolea tomentella*, *Sendtnera flagellifera*, *Cladonia rangerifina*, *C. cornucopoides*, etc. On the dry exposed rocks, *Racomitrium lanuginosum* forms large patches, which become brittle during intervals of dry weather, but revive with the first showers: this is the only locality in which it descends to the sea-level in New Zealand. Growing amongst the cool mosses are several delicate ferns, *Hymenophyllum sanguinolentum*, *H. rarum*, *H. multifidum*, and especially *Trichomanes reniforme*. Other ferns of coarser growth are not uncommon, while *Cheilanthes sieberi*, a characteristic plant of the Auckland volcanic district, is plentiful on the driest rocks. One of the most interesting plants on the island is the tropical *Psilotum triquetrum*, which occurs in abundance, usually springing from the face of rocks. *Dendrobium cunninghamii* produces its beautiful flowers in greater profusion and of larger size than I have seen them elsewhere, and the fragrant *Earina mucronata* is abundant. There is a sprinkling of grasses comprising eight or ten species, with a few common herbaceous plants, but the most interesting feature of the flora is the occurrence of *Metrosideros tomentosa*, *M. robusta*, *Griselinia lucida*, *Pittosporum crassifolium*, *Knightia excelsa*, and other trees, often in a diminutive condition, but laden with glossy foliage of the greatest luxuriance, and flowers of deeper and brighter tints than are produced under ordinary conditions.

On the clay cliffs of the adjacent islands, *Metrosideros tomentosa* attains a

height of from fifty to eighty feet, with a trunk from two to three feet in diameter; in its natural condition it rarely flowers before attaining the height of from twenty to thirty feet, but on Rangitoto compact charming specimens one to three feet high were covered with brilliant flowers; scarcely a plant was to be seen over twelve feet in height, but nearly all were splendidly in flower. Near the base of the cone I observed two specimens of a peculiar form of this species, with the leaves and flowers of smaller size than in the typical form; the leaves glabrous and coriaceous, closely approaching *M. polymorpha*. *Griselinia lucida* exhibited a similar phenomenon, specimens of the staminate plants being covered with panicles of yellow flowers, much more deeply coloured than I have seen them elsewhere, and forming a strong contrast with the fiery crimson of the pohutukawa. *Metrosideros robusta* was less common than its close ally, but occasionally attained a larger size, being only exceeded in height by *Pittosporum crassifolium*. Other trees occurred in a similarly dwarfed condition, as *Alectryon excelsum*, *Tetranthera calicaris*, etc., but all were cast into the shade by the bright flowers of the ratas and *Griselinia*. The vegetation of the cone itself is extremely meagre, diminutive specimens of *Leptospermum scoparium* and *Pomaderris phylicifolia* are mixed with species of *Geranium*, *Gnaphalium*, *Epilobium*, *Erechtites*, and especially with *Vittadinia australis*, a plant decidedly rare in the vicinity of Auckland. The whole presented but few points of interest.

I append a list of the plants catalogued on this remarkable island, and with a few observations on the cause of the peculiar condition of its ligneous vegetation will conclude this paper.

It has been pointed out that while the plants of this section are depauperated as to size, yet in other particulars they exhibit the greatest possible luxuriance; pigmy specimens of pohutukawa, *Griselinia* and others, develope foliage and flowers of larger size and brighter colours than those produced under the most favourable circumstances.

This result can only be attributed to the joint operation of two causes: the large amount of moisture present in the atmosphere, and the extremely comminuted condition of the small modicum of soil from which the plants extract their nourishment. The latter condition admits of a freer circulation of air, saturated with moisture, about the roots than is possible in stiff soils, and facilitates the absorption of the mineral constituents which are requisite for the growth of the wood, while the limited quantity in which these elements are available, and the brief occasional checks to growth during periods of drought, have a direct relation to the reduced size of the plants. The influence of atmospheric moisture is shown in the luxuriant and glossy foliage, thus affording another proof, if such be wanting, of the

absorbing powers of leaves, a function of late years overlooked, or altogether denied, by physiologists.

The lava fields of the Auckland Isthmus afford proof of the correctness of these conclusions. Although not more than from six to ten miles distant in a straight line their ligneous plants do not exhibit the same peculiarities as those of Rangitoto. Owing to the longer interval that has elapsed since their formation, a much larger quantity of soil is found amongst the rocks, so that in many places the titoki, mangiao, kohe-kohe, rewa-rewa and other trees attain their average dimensions. The largest specimens of *Griselinia lucida* that I have met with grew amongst the rough scoria near Mount Eden, but owing to the comparatively small amount of atmospheric moisture the leaves present an ordinary appearance, and the extremely luxuriant foliage so characteristic of the woody vegetation of Rangitoto is not developed.

Catalogue of Phænogamic Plants and Filices collected on Rangitoto Island.

I have to express my indebtedness to Mr. T. F. Cheeseman, for my knowledge of several interesting plants not observed by me, and have distinguished them by affixing his initials in each case.

* Naturalized plants are distinguished by an asterisk.

Dicotyledons.

Clematis indivisa, Willd. T.F.C.
Ranunculus plebeius, Br.
    hirtus, Banks and Sol.
    acaulis, Banks and Sol.
Cardamine hirsuta, L.
Lepidium oleraceum, Forst.
Melicytus ramiflorus, Forst.
Pittosporum crassifolium, Banks and Sol.
Stellaria parviflora, Banks and Sol. T.F.C.
**Silene quinquevulnera*, L.
Plagianthus divaricatus, Forst.
Linum monogynum, Forst.
Geranium dissectum, L., var. *carolinianum*, α. and β.
Pelargonium australe, L., var. *clandestinum*.
Melicope ternata, Forst.
Dysoxylum spectabile, Hook. f.
Pomaderris phylicifolia, Ladd.
Dodonæa viscosa, Forst.
Alectryon excelsum, DC.
Corynocarpus laevigata, Forst.
Coriaria ruscifolia, L.
Carmichælia australis, Hook. f.
Sophora tetraptera, Aitin.
Rubus australis, Forst., β. and γ. T.F.C.
Acæna sanguisorbæ, Vahl.
**Amygdalus persica*, L.
Tillæa verticillaris, DC.
Drosera auriculata, Backh. T.F.C.
Haloragis alata, Jacq.
    tetragyna, Labill., β. *diffusa*
Leptospermum scoparium, Forst.
    ericoides, A. Rich.
Metrosideros florida, Sm.
    robusta, A. Cunn.
    tomentosa, A. Cunn.
    ,, var.
    scandens, Banks and Sol.
Fuchsia excorticata, Linn. fil.
Epilobium nummularifolium, A. Cunn.
    tetragonum, L.
    junceum, Forst.
    pubens, A. Rich.
Mesembryanthemum australe, Sol.
Tetragonia expansa, Murray.
Hydrocotyle asiatica, L. T.F.C.
Apium australe, Thouars.

Dicotyledons—*continued.*

Apium filiforme, Hook.
Daucus brachiatus, Sieber.
Panax arboreum, Forst.
Schefflera digitata, Forst.
Griselinia lucida, Forst.
Coprosma robusta, Raoul.
lucida, Forst.
baueriana, Endl.
Galium umbrosum, Forst.
Olearia furfuracea, Hook. f.
solandri, Hook. f.
Vittadinia australis, A. Rich.
Lagenophora forsteri, DC.
Bidens pilosa, L.
Cassinia leptophylla, Br.
Gnaphalium luteo-album, L.
involucratum, Forst.
collinum. Labill.
Senecio glastifolius, Hook. f. T.F.C.
lautus, Forst.
Erechtites arguta, DC.
scaberula, Hook. f.
quadridentata, DC.
Brachyglottis repanda, Forst.
Sonchus oleraceus, L., *β. asper*
* *Helminthia echioides*, Gært.
* *Hypochæris radicata*, L.
* *Erigeron canadensis*, L.
* *Carduus lanceolatus*, Gært.
Wahlenbergia gracilis, A.DC.
Lobelia anceps, Thunb.
Selliera radicans, Cav.
Gaultheria antipoda, Forst.
Cyathodes acerosa, Br.
Leucopogon fasciculatus, A. Rich.
Myrsine urvillei, A.DC.
Samolus repens, Pers.
**Anagallis arvensis*, L.
Parsonsia albiflora, Raoul. T.F.C.
Geniostoma ligustrifolium, A. Cunn.
**Erythrea centaurium*, L.
Convolvolus sepium, L.
tuguriorum, Forst.
soldanella, L.
Dichondra repens, Forst.
Solanum aviculare, Forst.
nigrum, L.
**Physalis peruviana*, L.
Veronica salicifolia, Forst.
Vitex littoralis, A. Cunn. T.F.C.
Avicennia officinalis, L.
Myoporum lætum, Forst.
Chenopodium glaucum, L., var. *ambiguum*
Suæda maritima, Dumortier.
Salicornia australis, Soland.
Scleranthus biflorus, Hook. f.
Muhlenbeckia adpressa, Labill.
complexa, Meisn.
**Rumex viridis*, Sibthorp.
Tetranthera calicaris, Hook. f.
Hedycarya dentata, Forst.
Knightia excelsa, Br.
Pimelea prostrata, Vahl.
virgata, Vahl. T.F.C.
Euphorbia glauca, Forst.
Parietaria debilis, Forst.
Peperomia urvilleana, A. Rich.
Piper excelsum, Forst.

Monocotyledons.

Earina mucronata, Lindl.
Dendrobium cunninghamii, Lindl.
Bolbophyllum pygmæum, Lindl.
Acianthus sinclairii, Hook. f.
Microtis porrifolia, Spreng.
Thelymitra longifolia, Forst.
Prasophyllum pumilum, Hook. f. T.F.C., a single specimen only.
Orthoceras solandri, Lindl.
Triglochin triandrum, Mich.
Zostera "*marina*," L.
Cordyline australis, Hook. f. T.F.C.
Dianella intermedia, Endl.
Astelia cunninghamii, Hook. f.
Astelia solandri, A. Cunn.
banksii, A. Cunn.
trinervia, Kirk.
Phormium tenax, Forst.
Luzula campestris, DC.
Cyperus ustulatus, A. Rich.
Isolepis nodosa, Br.
Gahnia lacera, Steudel.
arenaria, Hook. f.
Carex lucida, Boott.
breviculmis, Br.
raoulii, Boott.
dissita, Soland. T.F.C.
lambertiana, Boott.
Paspalum scrobiculatum, L. T.F.C.

Monocotyledons—*continued.*

Panicum imbecille, Trin.
**Anthoxanthum odoratum*, L.
**Phalaris canariensis*, L.
Dichelachne stipoides, Hook. f.
crinita, Hook. f.
sciurea, Hook. f.
Agrostis æmula, Br.
billardieri, Br.
Arundo conspicua, Forst.
Danthonia semi-annularis, Br.
Echinopogon ovatus, Palisot.
**Cynodon dactylon*, L.
**Dactylis glomerata*, L.
Poa imbecilla, Br.
anceps, Forst.
**Briza minor*, L.
**Bromus sterilis*, L.
arenarius.
**Festuca myurus*, L.
littoralis, Br.

Cryptogamia.

Hymenophyllum multifidum, Swartz.
rarum, Br.
polyanthos, Swartz, *β. sanguinolentum*
demissum, Swartz.
Trichomanes reniforme, Forst.
humile, Forst. T.F.C.
Adiantum affine, Willd. T.F.C.
Cheilanthes sieberi, Kunze.
Pellæa rotundifolia, Forst.
Pteris aquilina, L., var. *esculenta*
tremula, Br.
Lomaria filiformis, A. Cunn.
Doodia media, Br.
,, var. *connexa*
Asplenium obtusatum, Forst.
lucidum, Forst.
Asplenium flabellifolium, Cav.
falcatum, Lam.
bulbiferum, Forst. T.F.C.
flaccidum, Forst.
Aspidium richardi, Hook.
Nephrodium glabellum, Cunn.
Polypodium grammitidis, Br.
serpens, Forst.
cunninghamii, Hook.
pustulatum, Forst.
billardieri, Br.
Nothochlæna distans, Br. T.F.C.
Botrychium ternatum, Swartz. T.F.C.
Lycopodium billardieri, Spring.
Tmesipteris forsteri, Endl.
Psilotum triquetrum, Swartz.

Art. LXXII.—*On the Export of Fungus from New Zealand.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 11th January, 1879.*]

In several striking characteristics Fungi bear a similar relation to all other plants to that borne by Insecta to all other animals. A larger number of plants is included in Fungi (regarded as a single order) than in any other group of similar value.* The largest number of similar animals is comprised under Insecta. Each group exhibits a large amount of polymorphism and parasitism. Each contains many species injurious to man, and but few from which he derives direct benefit. While other large groups of

* This assertion is at variance with the comparative estimates of the number of species comprised under different natural orders as stated in Botanical Text Books, but is warranted by the known results in countries where Fungi have been investigated with some approach to completeness. In Great Britain, for instance, over 3,000 species of Fungi are known, considerably more than twice the number of Phænogams and Filicales put together.

animals and plants are constantly yielding additions to the catalogue of organic substances directly or indirectly utilized by man, Fungi and Insecta, notwithstanding their vast numbers, but rarely assist to swell the roll. Any addition to the useful species of either is therefore of special interest, and on this, as well as other grounds, it is desirable to draw attention to the export of Fungus from this colony. It is practically restricted to a single species—*Hirneola polytricha*, Mont.,—which is plentiful on decaying timber in all our forest districts.

Prior to 1872, it was exported only in small quantities, but in that year the amount declared at the various ports in the colony was 57 tons 14 cwt., valued at £1,927; in 1877 it had increased to 220 tons 5 cwt., valued at £11,318; the total amount exported during the seven years ending 1878 being 838 tons, valued at £37,812. Its gradual increase will be seen from the following return, for which I am indebted to the Collector of Customs. Fractions are omitted for convenience:—

Year.	Tons.	Value.
1872	58	£1,927
1873	95	1,195
1874	118	6,226
1875	112	5,744
1876	132	6,224
1877	220	11,318
1878	103	5,178

From this it will be seen that the declared value is about £44 per ton, or more than four and a-half times the nominal price of one penny per pound paid by the merchant to the collector. As the fungus does not require to undergo any process to prepare it for market, the actual outlay connected with it is confined to the cost of collection and spreading in the open air or in sheds for a few days to get rid of moisture. This, however, is rarely necessary in the summer. At any rate, we have, in round numbers, the sum of £8,000 to represent the actual remuneration of the collectors, while the merchants' profit is represented by the disproportionate figure of £29,000. China is the sole market for our fungus. In 1873, at the suggestion of Mr. Seed, Commissioner of Customs, the Colonial Secretary made enquiry as to the purposes to which it was applied by the Chinese. The Colonial Secretary at Hong Kong stated in reply that it was "much prized by the Chinese community as a medicine, administered in the shape of a decoction to purify the blood, and was also used on fast days, with a mixture of vermicelli and bean-curd, instead of animal food." Later information shows that it is largely used in soups as ordinary food. It was further stated that it was sold retail at about 10½d. per lb. As the price paid to the collector in New Zealand does not exceed 1d. per lb., it is

clear that a high rate of profit must be realized by the merchant and retailer alike.

Specimens of our plant, from Christchurch and Wellington, were exhibited at the Vienna Exhibition under the name of Jew's-ear Fungus, *Hirneola auricula-judæ*, an allied species which occurs in the colony, but which is decidedly rare when compared with *H. polytricha*. The two plants may be easily distinguished, *H. polytricha* being greyish or cinereous, while *H. auricula-judæ* is usually of a pinkish tint.

Another species of *Hirneola* is collected in Tahiti for export to China, and a larger species, found in Northern China, is said to be extensively collected for home use.

We have thus before us the singular phenomenon of a product, utterly useless in the countries where it is found, being utilized by one of the least progressive people on the face of the earth, thus reversing the ordinary condition in which the civilized race utilizes the natural products of others less favoured.

Art. LXXIII.—*Description of a new Species of* Lycopodium.

By T. Kirk, F.L.S.

Plate XIX., fig. B.

[*Read before the Wellington Philosophical Society, 11th January*, 1879.]

Lycopodium ramulosum, n. s.

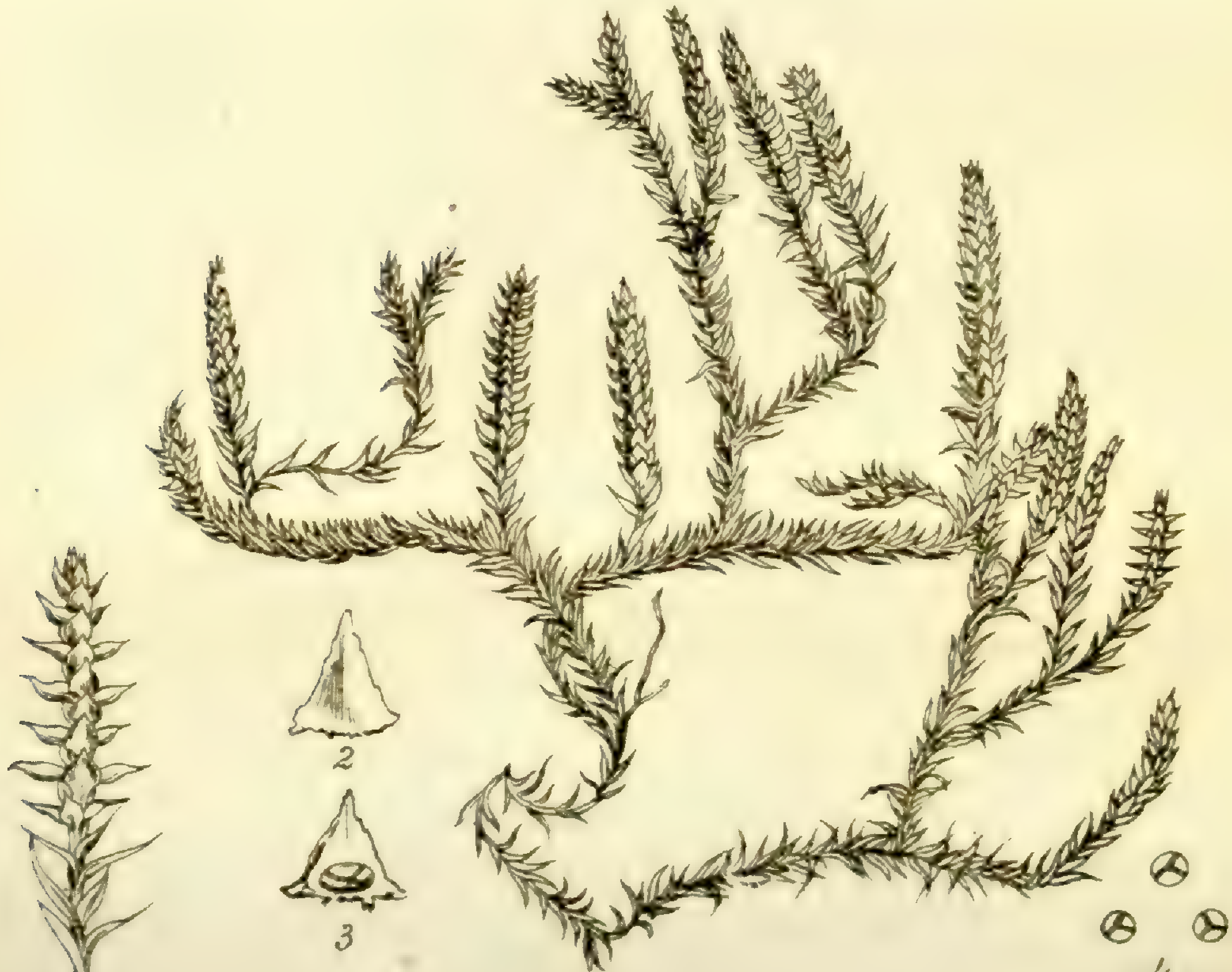
A procumbent plant forming compact masses; stems 2-4 inches long, rather stout, repeatedly dichotomously branched; leaves crowded all round the stem, imbricated or spreading $\frac{1}{5}$–$\frac{1}{4}$ inch long, narrow subulate, coriaceous above, acute or pungent; spikes numerous, terminal $\frac{1}{2}$–$\frac{3}{4}$ inch long, bracts small, sessile, ovate, abruptly acuminate, slightly toothed.

Hab.—South Island: Hokitika, *W. Tipler!* Okarito, *A. Hamilton!*

This plant differs from all other New Zealand species in its dense, compact habit; in some respects it closely approaches *L. laterale*, *β. diffusum*, but that form is always erect, or sub-erect, and never grows in compact masses; moreover, it is but sparingly branched, and never has terminal spikes. In all these points our plant is strongly marked, and may easily be recognized at sight. It was originally discovered near Hokitika by Mr. Tipler, and subsequently at Okarito by Mr. Hamilton. I am indebted to both gentlemen for a supply of specimens.

The spikes of our plant differ but little from those of *L. laterale*, Br., except in their greater number and smaller size. In the young state the

A. *HYMENOPHYLLUM RUFESCENS*, Kirk.



B. *LYCOPODIUM RAMULOSUM*, Kirk.

catkins are closely appressed, and ascending, but when the sporangia discharge their contents the tips of the scales become patent or even reflexed. The points of the young shoots are often of a reddish colour, and when growing in exposed situations the leaves become harsh and pungent.

Not unfrequently two spikes are produced from the apex of a branch, and rarely the fertile branch is overtopped by a luxuriant "usurping shoot," so that the spike appears to be lateral, showing its close affinity with *L. laterale*, which is still further strengthened by the fact that in that species the spikes are not invariably sessile, but occasionally are developed on very short leafy peduncles.

It is worthy of note that in *L. laterale* the spikes are frequently confined to one side of the stem.

Our plant has affinities also with *L. clavatum*, φ *magellanicum*.

L. laterale and *L. divulsum* are considered distinct by Bentham, in Flora Australiensis [Vol. VII., p. 675.] In New Zealand the latter form is not confined to alpine districts, but occasionally occurs in peaty bogs, from the sea level upwards, and notwithstanding its rigid appearance passes by insensible gradations into the typical form of *L. laterale.*

DESCRIPTION OF PLATE XIX., Fig. B.

Lycopodium ramulosum, n. s.

1. Old spike, with empty sporangia, enlarged.
2. Bract, outer face, magnified.
3. Bract, inner face with sporangium, magnified.
4. Spores, highly magnified.

Art. LXXIV.—*Description of a new Species of* Hymenophyllum.

By T. Kirk, F.L.S.

Plate XIX., fig. A.

[*Read before the Wellington Philosophical Society*, 11*th January*, 1879.

Hymenophyllum rufescens, n.s.

Rhizome creeping slender; stipes, costa and veins when young sparingly clothed with deciduous curved hairs; stipes, very slender, 1–2 inches long, longer than the frond; frond 1–1½ inches long, deltoid, sometimes cuneate at the base, pinnate, rachis winged above the second

pair of pinnæ; pinnæ twice pinnatifid, unequally rhomboid, the lowest pair divided nearly to the mid-rib; the basal pinnules spreading; capsules, terminal, small, half immersed, divided nearly to the base, hairy when young, margins entire or erose.

Hab: North Island—near the source of the Orua, Ruahine Mountains; 2,000 to 3,000 feet, *H. Field*, junr.! South Island—Okarito, *A. Hamilton.*

The affinities of this fern are with *H. æruginosum*, Carm. (*H. subtilissimum*, Kunze), and with *H. flabellatum*, Swartz. From the former it differs in the deltoid frond, in the form of the pinnæ, in the long and slender stipes, as well as in the delicate texture and partial hairiness. It resembles the latter in the shape of the pinnules, but differs in the stipes being longer than the frond, which is never ovate or linear, and the pinnules are never crowded. In habit our plant differs widely from both; in texture and colour it resembles *Trichomanes lyallii.*

The stipes, rachis, costa, veins and involucres are usually hairy, at least when young; but hairs are rarely produced from the surface of the frond; in *H. æruginosum* they are developed from both surfaces, and from the margins of the frond as well as from the veins; they are usually straight, and never deciduous as in our plant, my oldest specimens of which have very few hairs. The valves of the capsule are minutely erose in my young specimens from the Ruahine mountains, but this character is not developed in the mature specimens from Okarito.

This species was originally discovered by Mr. Field in the Ruahine mountains, and I was indebted to Mr. H. C. Field of Wanganui for a single young frond as far back as the early part of 1877, but it was not until the receipt of a supply of specimens from Mr. Hamilton, that I was able to satisfy myself of its specific validity.

DESCRIPTION OF PLATE XIX., Fig. A.

Hymenophyllum rufescens, nat. size.

1, 1. Pinna with capsule from old frond, enlarged.

2, 2. Pinna and capsule from young frond, enlarged.

Art. LXXV.—*Notes and Suggestions on the Utilization of certain neglected New Zealand Timbers.* By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 9th November*, 1878.]

There is probably no other British colony in which the vegetable products are wasted to so great an extent as in New Zealand. I do not now refer to the wanton destruction which, in the North Island especially, accompanies

the utilization of timber, and for which the next and succeeding generations will suffer, nor yet to that necessary destruction over areas in process of settlement, so much as to the general neglect to utilize timbers which would command a constant market at remunerative prices in Britain, and in the common use, in the Northern districts at least, of best timber for purposes that would be equally well served by timber of an inferior quality. In the former case the evil is the result of ignorance; in the latter of wantonnesss.

The magnificent kauri forests of Auckland have often enabled that district to pass through periods of difficulties, with comparative ease, by finding employment for numbers who would otherwise have been destitute. But at the present increasing rate of consumption, this source of wealth will have become exhausted within thirty years; the export of kauri will have ceased long before the expiration of that period, and there is no timber in the colony by which it can be replaced. The suggestion of any means by which this period can be retarded is therefore a matter of general interest, and from this point of view the utilization of certain neglected timbers, which, although inferior to kauri, are still valuable for general purposes, is one of considerable importance.

Again, there are many neglected timbers of great value for general cabinet work, marquetry, or other special purposes, which might assist to swell our catalogue of exports, and for which a constant market might be secured. In most cases these timbers have been neglected from simple ignorance of their value, but the excessive cost of land or water carriage to the port of shipment has too often proved an insuperable obstacle; this, however, thanks to the public works policy of the last few years, is being diminished almost month by month. The high cost of labour has also contributed towards perpetuating the neglect. The owner of a saw-mill, after clearing his bush of kauri or other marketable timber, has not cared to incur the cost and risk of converting timber of unknown qualities and comparatively small dimensions for an uncertain market. Some of these timbers when growing are of solitary habit, which to the ordinary timber merchant would present an increased difficulty.

Although no class in a community can derive benefit from the extension of an industry without the community at large benefiting to a greater or less extent; yet it must be admitted that the small settlers in forest districts would benefit more largely than any other class by the utilization of these neglected timbers. Commencing with little or no capital, our settlers would gladly welcome the opportunity of converting a large portion of their timber into hard cash instead of ashes, and would thus be enabled to tide over the first years on their land with less difficulty than at present.

Let us suppose the case of a forest settler on the lower flanks of the Rimutaka, or in many parts of the Wairarapa, the Kaipara, etc. In clearing his land he finds trees of honeysuckle or rewa-rewa (*Knightia excelsa*), the timber of which is almost useless for out-of-doors work, on account of its perishable nature, while, as it is difficult of combustion, it is worthless for firewood; yet, placed in the English market it would fetch a much higher price for cabinet work than the so-called American Birch, which is retailed by the timber merchant at from 6d. to 12d. per superficial foot of inch thickness. The timber should be prepared by cutting into from 10 to 14 feet lengths, so as to be easily moved to a rough saw-pit, when it could be reduced to planking, say from three to six inches thick; or, if in the vicinity of a saw-mill it might be converted at a still lower rate, or perhaps sold in the log. When converted it should be "perched" or "stripped" in such a way that no two planks would be in contact, and a constant circulation of air should be maintained between them. In this condition it could be sold to local cabinet-makers or consigned to a merchant or agent for export. But it is necessary to offer a word of caution with regard to two points of considerable importance, for the neglect of either would lead to loss and disappointment. First, the timber should not be sent on board ship until it is thoroughly dry, or it will inevitably become foxey and tainted. Secondly, it is imperative that the consignee in England should be someone thoroughly acquainted with the timber trade, for it is certain that many valuable timbers and other products endure continuous neglect simply from their not finding their way into the proper channels of distribution in Britain. Dr. Hector informed me that the object most admired in the New Zealand Court of the American Centennial Exhibition, was a cabinet, constructed chiefly of rewa-rewa, which, after lying in the London docks for an indefinite period, had been picked up by a cabinet-maker, who recognized its value for his purposes, but who had been unable to learn from what country it had been brought, although striving to procure a further supply.

It is not easy to form an exact idea of the cost of conversion and delivery at the port of shipment, so much depends upon situation; the following may be taken as a sufficiently liberal estimate:—

Falling,	1d.	per cubic foot.
Logging / Conversion	3d.	" "
Cartage,	3d.	" "
Railway charges,	3d	"

Say tenpence per cubic foot, or seven shillings per 100 superficial feet. The settler would therefore obtain not merely remuneration for his labour, but a direct profit by selling the planking at so low a rate as one shilling

per cubic foot, and might expect to obtain from one shilling and sixpence to two shillings per foot cube. Freight to England would cost another shilling, so that while yielding a handsome profit to the settler, the rewa-rewa could be sold in London at rates equally low with those of other woods of similar or even inferior quality. But a still higher rate of profit might occasionally be obtained; in all ornamental woods exceptionally figured planks fetch higher prices than the ordinary forms, and this would often be the case with rewa-rewa, and timbers of a similar quality. There can be no question that, in a large number of cases, timbers of this kind would defray the first cost of the land and leave a considerable surplus, instead of being simply a source of expense as at present.

I would venture to suggest that some of our leading merchants might render good service to the community, at little or no risk to themselves, by shipping a marketable parcel of rewa-rewa and similar woods to London; doubtless, many persons could be found who would gladly supply planks at a much less price than I have named; for example, the Karori settlers engaged in cutting firewood, either leave rewa-rewa on the ground to perish, or deteriorate their general sample of firewood by mixing rewa-rewa with it, and selling the whole at about sixteen shillings the half-cord, or threepence per cubic foot. An offer to purchase all the planking they could bring, at about one shilling per cubic foot, would ensure a sufficient supply to enable the market to be tested with but little risk to the shippers. Possibly, a few settlers might combine to prepare a parcel for shipment, and divide the profits; but in either case it would be advisable to have the parcel, on its arrival in London, submitted at a minimum price to some well-known wholesale furniture manufacturer, or have it offered at one of the large periodical timber sales, taking care to have the qualities and uses of the woods clearly stated.

It is unnecessary to offer a complete list of the various local timbers adapted for furniture work or other special purposes, as particulars may be found in the report on the durability of native timbers published by the Public Works Department, as well as in Captain J. Campbell Walker's report on the organization of a forest department for New Zealand. I would, however, especially draw attention to the toro, tipau, mapau, and ngaio as valuable timbers, plentiful in certain districts, but at present only utilized for firewood.

But we have vast quantities of timber which do not possess sufficient durability to allow their being used for out-of-door work, although capable of being saturated with some preservative solution at a small cost, and thus made available for general purposes. Conspicuous amongst timbers of this class are the kahikatea and the tawa. The former is common throughout the

colony, attains large dimensions, and, under the name of white pine, is used in the southern part of the colony for inside work and other purposes where great durability is not required, but by no means to an extent commensurate with its actual merits. Unfortunately, in the converted state it is liable to the ravages of a small boring beetle. The tawa forms fully one-fifth of the entire forest of the North Island, but can scarcely be said to be utilized in any way except for firewood.

It would be difficult to over-estimate the advantages to be derived from the utilization of so large a quantity of neglected material; and with this view of the importance of the subject, I venture to suggest the desirability of experiments in this direction being undertaken by the Public Works Department, the more especially that they may be made at small cost. A cistern containing a solution of chloride of zinc, pyrolignite of iron, chloride of lime or kreosote, all of which are successfully employed in Europe, might be elevated some eighteen or twenty feet above the ground. The logs to be operated upon should be placed in front, and a cap firmly attached to the end of each, the cap being connected by a pipe with the tank above, when the pressure of the solution from the higher level would be sufficient to drive out any sap that might remain in the timber, which would then become charged with the preserving agent.

Our white pine is greatly superior to the American spruce, and would successfully compete with the best Baltic white deal in the English market, if it could be supplied at a low rate, say to sell retail, at from 12s. 6d. to 13s. per 100 superficial feet. It should be shipped in the form of 2½ by 7, 3 by 7, 3 by 9, or 3 by 11-inch planking, or in bulk. Wider planks, say 14 to 20 inch, would fetch proportionately higher prices. It would, however, be impossible to pay the present high rate of freight, but as ships not unfrequently leave our ports in ballast, it is possible that lower rates might occasionally be obtained. A gentleman engaged in supplying the Kaipara mills with kauri, informed me that he should be glad to deliver kahikatea logs at 1s. 6d. per 100 feet superficial; so that, allowing for waste and cost of conversion, the planking might be turned out at the mill at 4s. 6d. per 100 feet, but even this would require a very low rate of freight to allow of a fair profit to the consignee.

I may be permitted to mention a singular instance in which the development of our railway system has promoted the utilization of our neglected resources. In all parts of the colony, except Auckland, the rimu, or red pine, has long formed the chief timber used in the manufacture of furniture, but in most parts of the Auckland district it has been completely neglected. Even within twenty or thirty miles of the city of Auckland, hundreds of noble trunks, from forty to sixty feet in length, and of large

diameter, have been destroyed by fire every year in the process of clearing. This has arisen from the difficulty of conveying the timber by land, water-carriage not being available as in the case of the kauri; so that rimu, the cheap timber of the south, could only be obtained in Auckland at a higher rate than kauri, and as kauri has the advantage of being more easily worked than rimu, the latter has been rarely used by the cabinet-maker, notwithstanding the advantage it possesses in colour and "figure." But, since the construction of the Waikato Railway, I am assured that a change has taken place in this respect. Rimu is abundant at Drury, Pukekohe, Pokenoe, and other places along the line, and the settlers have taken advantage of the facilities for carriage placed at their disposal—they have converted their rimu into boards instead of burning it, and rimu furniture is much more common in the workshops of the Auckland cabinet-makers than was the case prior to the formation of the railways. We may fairly expect that similar results will take place with regard to other neglected products.

Art. LXXVI.—*Descriptions of New Plants.* By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society*, 1st *March*, 1879.]

Compositæ.

Olearia oleifolia.

A much branched shrub 5 to 8 feet high; branchlets crowded, strict, ascending, angular, clothed with short velvetty pubescence; leaves 2″ to 3″ long, $\frac{1}{3}$″ to $\frac{1}{2}$″ wide, coriaceous, shortly petioled, narrow lanceolate, acute, erect, minutely reticulated above, white beneath with matted appressed hairs forming an even surface, veins obscure; corymbs on slender peduncles twice as long as the leaves; heads numerous on slender pedicels, involucre narrow, $\frac{1}{3}$″ to $\frac{1}{4}$″ long, cylindrical, scales few, inner membranous, linear, ciliated, pubescent; florets 4–5, two or three with a broad obovate ray; pappus hairs white, scabrid at the tip; achene furrowed silky.

Hab: South Island—Ashburton, *T. H. Potts!* Rangitata, 4,000–5,000 feet, *J. F. Armstrong!* Preservation Inlet, Otago, *J. D. Enys!*

For my first knowledge of this plant, I am indebted to Mr. Potts, who showed me specimens under cultivation several years ago, and expressed his belief in its specific distinctness, although he had not seen flowers. A living plant kindly given me by Mr. Armstrong in 1873 flowered for the first time in February, 1878. Its affinities are with *O. avicenniafolia* and *O. albida*, from both of which it is distinguished at sight by its strict habit,

excessively crowded branchlets, and narrow leaves. In the inflorescence it approaches most closely to the former, but differs in the narrow involucral scales with green tips, and the longer involucres. The leaves are less evidently reticulate on both surfaces.

Raoulia apice-nigra.

A small densely-tufted plant, forming compact masses, 2–5 inches in height. Leaves densely imbricated, ovate spathulate, obtuse, covered with snow-white loosely appressed hairs. Heads $\frac{1}{8}''$–$\frac{1}{5}''$ long; involucral scales linear with scarious margins and black tips. Pappus hairs white, scabrid near the tip, but more thickened. Achenes glabrous.

Hab: South Island—Mount Monro, Awatere, 5-600 feet, *P. McRae* and *T. Kirk.* Ben Lomond, Otago, 5,500, D. Petrie.

A singular plant: immediately before flowering the heads are black and glossy, presenting a marked contrast to the snow-white leaves. It is most closely allied to *R. australis,* from which it is distinguished by the black-tipped involucral leaves.

SCROPHULARINEÆ.

Veronica armstrongii.

A dwarf much-branched shrub, 1–3 feet high. Leaves minute, dimorphic. 1, linear, patent, or sub-patent $\frac{1}{10}''$–$\frac{1}{8}''$ long, acute. 2, closely appressed, tumid and coriaceous, adnate with the branch for half their length, broadly ovate, sub-acute, margins faintly ciliated. Flowers in terminal 3–8-flowered heads, sessile; sepals ovate-lanceolate with a strong median nerve ciliated. Corolla tube short, limb $\frac{1}{6}''$–$\frac{1}{5}''$ in diameter, whitish. Capsule ovate acuminate, longer than the sepals, slightly tumid and notched at the apex.

Hab: South Island—Nelson, Upper Wairau and Amuri 3–4,500 feet, *T. Kirk.* Source of the Rangitata, 4–6,000 feet, *J. F.* and *J. B. Armstrong.*

Our plant presents the appearance of a hybrid between *V. salicornioides* and *V. hectori*, and must, I think, be considered of doubtful specific validity. In its robust habit and subacute appressed leaves, it resembles *V. hectori*; it is more closely allied to *V. salicornioides* by the inflorescence and capsule, as well as by the arrangement of the appressed leaves, the upper portion being free and widened out, so that each pair of leaves forms a minute funnel-shaped cup surrounding the branch, and presenting a curious articulated appearance resembling some corallines.

The appressed leaves are not constantly ciliated in any of the forms belonging to this section, and in this respect vary greatly even on the same branch. The same remark applies to the glandular dotting of the leaves, which is characteristic of *V. hectori*, *V. armstrongii*, and *V. salicornioides*—at least I do not find the leaves truly connate in either plant, although in close contact for the length of their base.

All the Otago specimens of *Veronica hectori* that I have seen are more robust than those from the Canterbury and Nelson mountains; the length of the capsule varies considerably.

Notwithstanding the doubts I entertain of the claims of our plant to specific honours, I have great pleasure in describing it under the name by which it has become known to horticulturists. As it adapts itself to artificial conditions more readily than any other species belonging to the section (except perhaps *V. cupressoides*), and is easily recognized by its flabellate branches, it will probably retain its name even if it should ultimately be considered a form of *V. salicornioides;* but it would have afforded me greater pleasure to have attached the name of its discoverer to some form more likely to prove of permanent specific value.

The dimorphism in the foliage of all the species characterized by appressed leaves has not received the attention it merits. The spreading leaves are easily produced under cultivation; if the plants are kept in a cool, shaded situation, they will be developed from the tips of branches bearing appressed leaves as well as from all newly formed branches. In *V. cupressoides* the free leaves are ovate, lobulate or nearly pinnatifid. There can be little doubt that the free leaves are equally characteristic of the seedling state of the plant, although I have been unable to find them in a wild condition.

Many of the New Zealand species of *Veronica* comprise a series of forms capable of being recognized by the eye, especially when their minute differences are exaggerated under the luxuriant growth induced by cultivation, but they pass into each other by insensible gradations, and are not capable of rigid definition. In this respect they resemble *Rosa canina*, *Rubus fruticosus*, and *Salix repens* of Northern Europe; and the trivial varieties and sub-varieties of our Veronicas are no more worthy of being elevated to specific rank than the varieties and sub-varieties of these variable European plants.

Plantagineæ.

Plantago hamiltoni.

Stem very short. Leaves rosulate, $\frac{1}{2}''$–$1\frac{1}{2}''$ long, more or less clothed with scattered jointed hairs, linear lanceolate, toothed or nearly entire, narrowed into a broad petiole, with shaggy hairs at the base. Scapes 1-flowered, crowded amongst the leaves, at first very short $\frac{3}{16}''$–$\frac{5}{16}''$ long (always ?) elongating as the fruit matures; sepals short, broad, obtuse; corolla tube narrow, lobes acute, spreading, ovary large, ovate. Capsule (always ?) when ripe on an elongated scape $\frac{3}{4}''$–$1''$ long, very large, fully $\frac{1}{8}''$–$\frac{1}{10}''$ broad, ovate, apiculate, glabrous, imperfectly 4-celled, cells 2-seeded.

Hab: South Island—mouth of the Grey River, *A. Hamilton.* Stewart Island (specimens not in flower, and identification therefore uncertain), *D. Petrie.*

The nearest ally of our plant is *Plantago uniflora* of the Ruahine Mountains, which at present has only been collected by its discoverer, Mr. Colenso. *P. hamiltoni* is distinguished by the ovate, obtuse sepals, prominent midrib, the flowers on abbreviated scapes which elongate as the capsule approaches maturity, and especially by the capsule, which is the largest in the genus.

Mr. Petrie's specimens, from marshes on Stewart Island, are less hairy than those from the Grey, and the leaves are not so strongly toothed; but these characters vary greatly in all species of *Plantago*, and in this case are partly due to difference of habitat, Mr. Hamilton's plants having been collected on shingle.

I have great pleasure in associating the name of its enthusiastic discoverer with this interesting species.

Art. LXXVII.—*Notice of the Discovery of* Calceolaria repens, *Hook. f., and other Plants in the Wellington District.* By Harry Borrer Kirk. Communicated by Mr. T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 1st March,* 1879.]

During a walking excursion from Wellington to the Wairarapa, returning by the coast, I was fortunate enough to find in a small gully on the Rimutaka mountains, several plants of *Calceolaria repens*, hitherto, I believe, unknown in this district. The plants grew on the side of the gully, on a mass of loose, crumbling rock, covered with dead leaves and rotten twigs.

C. repens is a small, creeping plant, with slender stems and alternate, ovate, deeply serrate leaves, the whole slightly pubescent. The flowers are distant and borne in three- to six-flowered panicles. They are small and white, with a few purple spots on the throat. The two lobes of the corolla are nearly equal.

The plant was first discovered by Mr. Colenso, in the Ruahine mountains. My father's herbarium contains specimens from the East Cape, collected by the Venerable Archdeacon Williams. It has, I believe, been collected at Mount Egmont by Mr. J. Buchanan, but is not mentioned in his list of Taranaki plants. As these were its only known habitats, its occurrence in the Rimutaka range shows a great extension of its limit southward.

During the excursion several other plants were collected, which appear to have escaped Mr. Buchanan's notice, as they are not mentioned in his list of South Wellington plants. The following are the most remarkable :—

Ranunculus hirtus, Banks and Sol. Mungaroa.

Oreomyrrhis colensoi, Hook. Mungaroa. This plant occurs also on Mount Victoria.

Loranthus tetrapetalus, Forst. Mungaroa.

,, *decussatus*, Kirk. Mungaroa.

Nertera cunninghamii, Hook. Wairarapa Lake. Occurs also on Mount Victoria.

Haloragis micrantha, Br. Mungaroa. Found also close to Wellington.

Olea montana, Hook. Pakuratahi.

,, n.s. Mungaroa.

Urtica incisa, Poiret. Mungaroa; common.

Gunnera monoica, Raoul. Mungaroa.

Rumex flexuosus, Forst. Wairarapa Lake. The absence of this plant from the immediate vicinity of Wellington is not easily accounted for.

Tillæa moschata, DC. } Palliser Bay; also at Miramar.
,, *debilis*, Col. }

Cassinia retorta, A. Cunn. Mungaroa.

Raoulia glabra, Hook. Rimutaka.

Chiloglottis cornuta, Hook. Wainui-o-mata.

Corysanthes oblonga, Hook. Mungaroa.

,, *macrantha*, Hook. Okiwi.

Pterostylis trullifolia, Hook. Okiwi.

Carex breviculmis, Br. Mungaroa; common.

,, *lambertiana*, Boott. Mungaroa.

Gahnia hectori, Kirk. Mungaroa; common.

Cladium gunnii, Hook. Mungaroa.

Uncinia ferruginea, Boott. Mungaroa.

Cyperus buchanani, Kirk. Waiwetu.

IV.—CHEMISTRY.

Art. LXXVIII.—*Preliminary Note on the Presence of one or more Hydro-carbons of the Benzol Series in the American Petroleum, also in our Petroleums.* By William Skey, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 17th August,* 1878.]

It is generally supposed that the benzol series of hydro-carbons is not represented by any constituent of American petroleum, nor even as far as I know in any true petroleum at all. Any way, so far as the American oil is concerned, we have it reported in the special report on the Petroleum of Pennsylvania by the Geological Survey there that Dr. Genth "believes that the series of hydro-carbons characteristic of those which furnish aniline, etc., do not exist in our American oils." And, again, Dana informs us in his latest edition of System of Mineralogy that "none of this series were detected by Pelonze and Cahours in the Pennsylvania petroleum."

However, some time ago I had, on behalf of the Customs authorities here, to examine some of our so-termed benzine for what is chemically known as benzol—hydro-carbon; and for this I employed the test recommended by Prof. Hoffman—a test which is based upon the fact that benzol loses a portion of its hydrogen when warmed with nitric acid; the remainder combines with a portion of decomposed acid to form intro-benzol, and this product, when placed in contact with nascent hydrogen, is by the loss of oxygen transformed into the alkaloid aniline—a substance which is by certain easy oxidizing processes converted to others which are remarkable for their intensity and variety of colour, forming the well-known coal-tar colours.

The results of his test were, that I entirely failed to get any *colour reaction;* but I obtained a quantity of nitro-oils, from which I succeeded in separating one which by deoxidation yielded a substance which exhibited all the general properties of an alkaloid; thus it is soluble in water, combines with acids, and, when dissolved in either, gives precipitates with tannic acid, mercuro-iodide of potassium, and sulpho-cyanide of zinc. It is an oil, at common temperatures, possessing a dark brown colour, and, like aniline, it gives an intense yellow colour to pine-wood.

As this substance, though clearly an alkaloid, does not yield any colour reaction with oxidizing agents (such as chloride of lime), it is neither aniline nor naphtha-aniline, and therefore is not derived from either benzol or naphthaline, and so does not indicate the presence of these hydro-carbons in the oil tested. The alternative is, then, that it is derived from a hydro-carbon or some hydro-carbons of the series which benzol heads and typifies, and which is in all probability either touluole or xylole, or a mixture of the two.

Having obtained this result I extended my researches, and so have ascertained that all the brands of American kerosenes which we have here, together with the so-termed benzols, also contain hydro-carbons, which are capable of yielding alkaloids to the process I have described (the aniline process), but still give no colour reaction to oxidizing agents.

Our own petroleums, both the heavy (Taranaki), and the light one (Poverty Bay), as well as their distillates light and heavy, also behave in this respect like the American oils.

In the case of the Taranaki crude petroleum in particular, this series of hydro-carbons is well represented—that is, quantitatively.

The nitro-oil of this petroleum (the first product of the process employed), when cleansed from the unaltered oil by repeated solutions in alcohol and precipitations by water, has a sweet and powerful odour much resembling that of nitro-benzol.

The facts detailed above lead me to suspect that every petroleum contains one or more representatives of the benzol series of hydro-carbons. Which particular member of this group (or which members, if more than one) is present in the several oils I have cited, I cannot inform you until I have ascertained the composition of their respective alkaloids, a labour of so tedious a kind, that I cannot promise to perform it for some time to come.

Art. LXXIX.—*On a Property possessed by Essential Oils of whitening the Precipitate produced by mixing a Solution of Mercuro-iodide with one of Mercuric-chloride.* By William Skey, Analyst to the Geological Survey of New Zealand.

[Read before the Wellington Philosophical Society, 17th August, 1878.]

In article 83 of the last volume of our Transactions,* I showed that solutions of certain alkaloids and albumenoids, made so weak that they will not give any precipitates with mercuro-iodide of potassium, will give them immediately that a little mercuric-chloride is mixed therewith, in addition

* Trans. N.Z.I., IX., p. 553.

to the first-named mercuric salt, and that such precipitates are of a pale yellow colour, which is in striking contrast to the full red colour which the precipitate would exhibit were neither of these organic substances present, since this precipitate would be iodide of mercury alone.

Continuing my researches in this field, I have ascertained that there is another class of organic bodies, besides alkaloids and albumenoids, which determine a yellow colour to the precipitate, which is formed when aqueous solutions of mercuro-iodide of potassium and mercuric-chloride are mixed, and this is that of the *essential oils*. I therefore hasten to inform you of this fact, and to acquaint you with a knowledge of the means which I find may be used to discriminate, for toxicological purposes especially, the mercurial precipitates so coloured, from those which are coloured by the presence therein of an alkaloid or an albumenoid.

The yellow mercurial precipitates, which are formed by this means in presence of these oils, volatilize entirely when gently heated, and their sublimates preserve their yellow colour, even when kept cool a long time. This reaction distinguishes such precipitates from those which are formed in part of a fixed alkaloid, also of an albumenoid; while from those formed in part of a volatile alkaloid they are distinguished by not reddening when treated with mercuric-chloride.

I find that a very minnte quantity of any of these oils is effective for the production of the phenomena I have described; for instance, one part of lemon oil to 10,000 parts of water will produce it.

The nitro-oils behave in this case in the same way as the essential oils. The nature of the mercuro-precipitate, which is thus formed in presence of an essential oil, I am unable as yet to determine for lack of time.

ART. LXXX.—*Preliminary Note on the Production of one or more Alkaloids from Fixed Oils, by the Aniline Process.* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.

[Read before the Wellington Philosophical Society, 17th and 31st August, 1878.]

MY late successful production of alkaloids from our petroleums* induced me to apply the same process I used in that instance to the fixed oils, that is the process I name in the title of this paper, for brevity, the "Aniline Process;" one which, I may remind you, consists in first warming the petroleum, etc., to be treated, with nitric acid, by which numerous *nitro* compounds are produced; and, in the second place, deoxidizing these by nascent hydrogen, by which any hydro-carbons of the benzol series present

* *Vide supra*, Art. LXXVIII.

have a portion of their hydrogen replaced by the elements of nitrous acid, and subsequently, a portion of the oxygen of this acid removed, the ultimate result being that a nitrogenous substance is produced which is a true alkaloid, in fact an amide, that is, a substance constructed upon the ammonia type, and which, in case of those produced from petroleum, has one equivalent of hydrogen of ammonia substituted by a hydro-carbon.

Now, so far as I know, this process has not been applied with any success to a fixed oil or fat, if applied at all; every constituent of such substances is indeed held to be constructed so differently to the petroleums and their allies, that we should not expect results upon them at all similar to those we get by the same means as applied to the petroleums.

However, by employing this process very carefully upon the purest olive oil I could get, I obtained as a resultant a liquid which manifested, to all the tests I could apply, the reaction of one containing an alkaloid.

By employing Stras's process to this liquid I separated an oily body which was in great part dissolved by weak acetic acid; the solution in this acid afforded dense precipitates with tannin, mercuro-iodide of potassium, sulpho-cyanide of potassium and zinc, a reddish precipitate with free iodine, and when evaporated with platino-chloride of potassium a granular yellow precipitate; this precipitate, when washed well with alcohol to dissolve any oil present in a free state, partially fused when gently heated, and then blackened, and as the heat was raised the black matter was consumed, and a grey mass of platina left.

These results clearly show that an alkaloid had been obtained from the oil used.

Several other vegetable oils gave similar results to these, and among the animal oils, cod-liver oil and sperm oil. The former oil was obtained from the fish by steam, so that the alkaloid produced is not to be referred to any product of decomposition made by securing the oil. That this alkaloid is not to be referred to the glycerine of these oils is proved by my inability to obtain an alkaloid in this way from glycerine itself; and further by the fact that Price's stearine, as sold in his candles, also affords me this alkaloidal substance. These candles do not contain glycerine, and are the best representation of a pure fat which I can at present get.

These facts open up a very interesting field for research, as they show one of two things, viz.:—First, that there are one or more hydro-carbons of the benzol or naphthaline series in our fixed oils and fats:—second, or that the acids of these substances are in part capable of furnishing alkaloids to the aniline process.

Whichever way it may prove to be, the matter is of an equal interest, for that there should be pure hydro-carbons mixed with the fixed vegetable and animal oils named, would be just as important a fact to know, as that

our oxygenated oils yield alkaloids to a process which hitherto has been considered applicable to hydro-carbon oils alone, and even of these but very few.

I should inform you that none of the oils, etc., cited above, when tested for alkaloidal matter gave any indication of its presence, although I operated in each case upon the same quantity of oil as that I used for the aniline process.

The constitution and precise character of the alkaloid or alkaloids I have thus formed I cannot at present describe to you, as I have not yet the leisure to prosecute this investigation to the end. I hope to take up this subject on some future day, but in the meantime I shall be glad to hear of any one continuing the research, as it can hardly fail to give results of great interest.

POSTSCRIPT.—I have further pursued my investigations of this subject, and of the two alternatives I have submitted to you in respect to the derivation of the alkaloid I produce by this process, I accept that which assumes it to be a product of some hydro-carbon or hydro-carbons present in the oil or fat employed. I have produced alkaloids by this process from well-washed butter, the purest sperm, and olive oils; and I now make the general statement that there is present in all the fixed oils or fats, whether of vegetable or animal origin, whether in the organism or removed from it, a small quantity of one or more hydro-carbon oils, and that these, or at least some of them, are homologous with benzol.

ART. LXXXI.—*On the Cause of the Movements of Camphor when placed upon the Surface of Water.* By WILLIAM SKEY.

[*Read before the Wellington Philosophical Society*, 31*st August*, 1878.]

IT has long since been known that camphor in small pieces describes rapid and very eccentric movements when placed upon water, the surface of which is free of oily matter. This phenomenon is so singular,* and is, besides, so striking to him who for the first time witnesses it, that such an one can hardly help feeling anxious to become acquainted with its cause,

* I have since discovered that the liquid bi-sulphide of camphor behaves in this respect like camphor. If the water used with it is quite clear from greasy matter, it spreads in various directions by a series of explosive efforts; but if the water contains a minute quantity of grease (as it will do if especial precautions are not taken), the sulphide of camphor, after a little while, rotates slowly round its centre, then rotating progressively aster, it at last strikes off in a straight line, leaving a greasy narrow streak behind, which is permanent.

and the more so when, on enquiring into this, he learns that no one has yet published anything in explanation of this phenomenon which is backed either with any kind of authority or, what is more, by a weight of evidence sufficient to recommend it for his unqualified belief.

It was just under these incentives to research that, a little while ago, I commenced investigating this phenomenon, and with the additional one of ultimately finding something in common between it and that of the motion of minute particles in certain liquids—one known by the appellation of "Browinian movements"—the Pedetic movements of Prof. Jevons.

After I had made a great number of experiments with camphor, however, I could find nothing which gave any proof in favour of a common origin for the two phenomena. Neither could I find anything in support of the theory popularly assigned for the explanation of that exhibited by camphor, but instead, evidence of a very decided character, pointing, as I think, very clearly to quite a different origin for it than that which is assigned by the theory in question. This I now ask leave to submit to your inspection, and, if you will allow me, I will do this in the same order, or nearly so, in which it was educed.

First, I will remind you what this theory is, which is thus endorsed by popular opinion. It is based upon the fact that camphor gives off vapour at common temperatures, and it is to the unequal impingement of this vapour upon the water around it that the movements in question are ascribed, the camphor being held, as I suppose, to move in the direction of least evaporation.

Now this does, I allow, appear at first thought quite explanatory to anyone who will observe the effect which camphor vapour, or vapours, generally have upon water, the surface of which is prepared so as to indicate any modification it thereby undergoes. Such a surface, in the case of water, is easily got by dredging a little very finely-powdered resin evenly upon it.*

Camphor suspended close to a surface of this kind produces, as you see, an instantaneous recession of the resinous particles from the point immediately under it; the same effect is also produced by those substances generally which give off vapour in suitable quantity at the temperature at which they are used; for instance, alcohol or ether.

It does, indeed, appear from this, that the popular theory which we are attacking is, after all, correct. One sees the resin quickly dashed away from the camphor, etc., and in consequence conclude that, as action and reaction

* This surface so well indicates (by the displacement of resin) the presence of oily matters that these can readily be detected, as they escape from the finger applied thereto, even immediately after a thorough wash.

are equal, each of the substances whose vapours we are operating with, is at such times subjected on all sides to a force tending to drive it in, that is, towards its centre; a force which, as it cannot be persistently equal around it, will certainly move it from its normal position.

This is, I allow, a conclusion which one is at first inclined to form; but I will now show to you an extension of this experiment yielding results which will, I think, at once prevent anyone previously so inclined from this conclusion.

The camphor is now only one-sixth of an inch above the water, and the diameter of the cleared space below it is about half an inch; I now lower it to within one-fortieth of an inch of the water, but you observe that the area of cleared space is not perceptibly increased, thereby showing that this is very closely upon the maximum of that which can be got by placing the camphor at an infinitesimal distance from the water. I now allow it the slightest contact with the water which I possibly can, and you observe that there is instantly a very large increase of cleared space, whose diameter is certainly not less than four inches, representing, therefore, an area no less than sixty-four times that which we had before.

Here, then we have, in one moment, an accession to our knowledge of a kind which teaches us that, whatever the direct radiation of camphor vapour may have to do with the production of the cleared space last got, there is some reaction of camphor with water of quite a different nature which has very much more to do with it; so great, indeed, is the effect produced by the merest *contact* as compared with that obtained by suspension in the most favourable position, that it really becomes a moot point whether any space at all is cleared by the direct impingement of this vapour on the water surface.

To settle this point by a demonstration I now reproduce certain experiments of mine:—This small sphere of camphor I suspend over water (prepared as above) within one-sixth of an inch of its surface, and across the cleared space produced, close to the camphor and closer to the water than the camphor is, I place this thin bar; now this clearing should have its shape materially altered, and its area much curtailed if it has been produced by the mere impingement of vapour on water; but you cannot see that any variation occurs whether in shape or area.

Again, I place a small piece of camphor on this prepared surface, and put a wide bar close to one side of it and very near to the water; now, action and reaction being equal there should occur a marked recession of the camphor from the bar if the evaporation theory is correct, for in the direction of this bar is the greatest resistance to the escaping vapour; but you cannot observe that anything of this kind happens.

Evidence of this sort, indeed, is to be had in every exhibition of these movements of camphor, for whenever the camphor gets to the vessel's side, it remains there motionless, whereas it should (according to the theory we are examining) rebound therefrom, with great force.

But apart from and independent of these results, it is, as I conceive, very questionable whether any vapour emanating from a substance which is of the same temperature as its environment, and in presence of air, has a direct repellent effect thereon. However, this is a question of so general a character that I cannot well extend the scope of this paper so far as to take it into consideration now, but if you will allow me I will trench upon it so much as to inform you of a few very interesting facts which are connected with it, and also in an especial manner with the particular phenomena we are considering.

Experiments.—Two pieces of camphor swung in air in close contiguity, at the ends of very fine and long threads, do not manifest any repellent effect in regard to each other, while, if placed upon water, though at first there is an *appearance* of a mutually *repellent* force in action, there is, after a short time has elapsed, an *appearance* of a mutually *attractive* force—they actually, as you see, *move toward* each other and close together. Now, you will allow that these results are not consistent with the theory which credits vapour with direct repulsive effects. The case of turpentine is something similar to the above. It is a substance which gives off vapour more freely than camphor, yet when one sprinkles fine particles of cork upon it and applies its vapour thereto, one cannot observe that the cork is at all affected thereby. But not only this, one can get the very reverse of repulsion during the emission of vapour; thus, upon either turpentine or kerosene a small piece of cork is placed, and a rod moistened with ammonia is then brought to within about half an inch of it, when the cork may be observed to positively rush to the rod and follow it about as obediently as a needle can respond to the movements of a magnet.*

Taken as a whole, the results which I have just described or exhibited to you, do, as I conceive, indisputably show that this recession of particles under the influence of camphor is, appearances notwithstanding, not due to the direct impingement of vapour on them, but rather to some effect following thereupon; and it seems therefore necessarily to follow that the movements of this substance (camphor) on water, are also not the direct result of impingement, but the result of something which follows it.

And now, with the popular theory thus disproved before you, it may occur to some one here, as it did to me, that possibly these movements of

* Volatile acids, also water, applied in this way have the reverse effect, while turpentine is neutral. The rod alone, if warm, has also an apparent repulsive effect on the cork.

camphor are the effect of electrical reactions, but that this is not so appears from the fact that neither of the poles of a six-pair Grove battery, in full action and in good working order, at all effects these movements when applied close to the camphor. The poles were pointed in order to be in the most favourable condition for effect.

The ground being thus cleared, it remains for me to tender for your approval a theory which, in my opinion, explains the phenomena in question. This I will do, and along with it I will describe or demonstrate, as the case admits, the experimental results upon which, in conjunction with those related above, this theory is based.

You will perhaps remember that in the introductory part of this paper Is tated to you the well-known fact that, for the exhibition of the movements, which I now desire to explain, it is necessary to have the water-surface free from oily matters. Now a knowledge of this is highly suggestive ; it is as you will find the key to the question before us. A drop of oil (as you observe) stops in a peremptory manner all camphor movements, and it is now our proper course to enquire how it effects this. It can only, so far as I see, effect this in two ways, either by enfilmning the camphor and so preventing evaporation, or it is not as a suspensive medium favourable to the continuance of such movements; that this last is the case is shown by the following experiment.

I float a small piece of cork upon turpentine, on this cork I place camphor, and you observe that we get no camphoric movement.* Clearly then it appears that whether we are to get the phenomena or not depends upon the nature of the surface of the liquid which we use for flotation, and this independent of any effect it may have upon the solid camphor in preventing its evaporation. The knowledge of the fact that oils generally are, *in this particular respect*, antagonistic to camphor-movements I sought to amplify, and in this I have succeeded. Thus I find that besides them alcohol, ether, bi-sulphide of carbon and ammonia, applied even as vapours, and only in minute quantities, arrest camphoric movements very quickly. I further find that such movements are very much less rapid and prolonged if the water used is charged heavily with either acids or salts.†

Being thus acquainted with the fact that so many and such diverse substances as those just above cited, render water unfavourable for camphoric

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* This fact, by the way, is corroborative of the correctness of the opinion I have ventured above, viz., that camphor movements are not caused directly by the impingement of its vapour upon the liquid which floats it.

† I have since found that, in singular opposition to these vapours, etc., gasoline not only refuses to stop or retard camphoric movements, but even starts them in case of camphor rendered stationary in this way.

movement, it occurred to me to try camphor itself. I placed a large piece of it upon water in a vessel closed from the air, and found, after the lapse of about four hours, that it was stationary, and that fresh pieces put therein would not move. I then took out the camphor and exposed the water freely to the air for a short time, when I found that camphor would then describe very lively movements upon it. The same kind of effects are not produced if the camphor is kept wholly immersed in the water, not even if the time of contact is prolonged to a week. I further found that a water-surface, which has been rendered unfavourable for these movements by camphor, is also in a very unfavourable condition for the spread of oils thereon, so much so that some of them, when so placed, that is, of course, when used in small quantity, keep nearly to the drop form.

The very pertinent facts are, then, now distinctly shown, that many vapours are obstructive to camphoric movements when condensed within or upon the upper stratum of any water on which camphor is moving, and that among these substances is camphor itself. Now we have already seen that all the substances just named above (and this includes *camphor*) are capable under certain circumstances of giving very decided and rapid movements to solid particles when they occupy a water-surface; and we have also seen that these vapours do not effect this *directly* by what I may here designate *vapour force*, but rather by *surface modification*. The conclusion, therefore, which one is led to by a consideration of all this is, that the movements of camphor in question are the effect of *surface modification* and *modification which it produces itself*.

The analogy is, I hold, complete between resin upon water moving away from that which has been modified by vapour, and camphor upon water moving away from the water it has modified, except that we have one substance less in the latter than in the former case—thus, camphor placed upon water gives up a part of its substance to the upper stratum thereof; this part represents the vapours, whether of alcohol, ether, or camphor, which are resident in the clearing they have made amongst the particles of resin with which the water has been laden; the remaining part of the camphor represents the resin which has been removed to make this clearing.

Such is the theory which I submit to you as explanatory of the phenomena we have been observing. I think you will readily allow that it is at all events the most probable of any which you have now had for this purpose, and now it only remains for me to state to you what I conceive to be—

1. The precise nature of the surface modification which I have credited camphor with producing.
2. The manner in which a surface so modified forces camphor to move.

First then in regard to the nature of this modification. Camphor, I should remind you, has properties affecting this question as follows :—It is soluble in water, and so without doubt combines with it; it is not decomposed by water, even in conjunction with air that is at common temperatures, and it is a resin slowly volatile at such temperatures.

Now camphor, as we have seen, modifies a very much larger extent of surface when placed in contact with water than when suspended over it. We may, therefore, be certain that the modification in question is not occasioned simply by a deposit of condensed camphor vapour upon the water surface, but rather by some combination of it with water. This combination, however, is not that which is obtained by saturating water with camphor in the ordinary way (a compound containing one part of camphor to one thousand parts of water), as is shown by the fact I have already stated to you, that a saturated solution of camphor in water allows camphor to describe movements upon its surface; this compound, therefore, is one new to us, it can only exist as a thin surface film, and is therefore doubtless one far richer in camphor than that which we already know of, a compound indeed so highly camphoretted that it, in all probability, partakes in an eminent degree of the characters of an oil.* However, it is impossible for me as yet to obtain direct evidence as to the nature of a film so exceedingly thin as this. We must therefore for the present rest content with the indirect evidence which we now have.

Granted, then, that the modification effected upon a surface of water by camphor is owing to a combination of the two for the production of a highly camphoretted oil, I have only now to show the precise manner in which this compound induces camphor to move.

For this purpose I will refer you to the effect which a drop of oil has when placed upon water laden with an indicatory substance, such as clay in fine particles; the oil spreads quickly and regularly around, and in the act urges the clay to the side of the containing vessel, where it becomes stationary. Now the clay and the oil here are, I hold, fairly representative of the camphor and its oily compound; there is this difference, however, in the movement of the oils, and it is an important one, it is a difference upon which all camphor movement depends,—the spread of oil in the case of camphor is not even around it, as is that of the other oil; were it so there would be no such phenomenon as that we are investigating. Regularity of spread is in this case impossible, because the production is irregular, owing to the highly crystalline nature of camphor, and its great fragility, whereby

* I have lately observed that water thus modified, when compared side by side with pure water, exhibits a higher lustre than the pure water does, a fact greatly in favour of this view.

one cannot obtain a homogeneous sphere of it for use, or if one could it would at once lose its character and shape. The oil then being of necessity produced irregularly around the camphor spreads unequally from it, and in the act urges it in a direction which is away from that side on which there is the greatest output of oil; thus the camphor breaks through the oily film at its weakest part, and sets itself upon the edge thereof, which position it retains so long as there is motion produced. The movements of camphor are, in short, the joint results of the outward spread of oil along the water surface—the inertia or adhesiveness of this oil as regards what surface it thus occupies—and, lastly, the antipathy, as it were, which exists between the two, the camphor and its oil, whereby they refuse to associate.

But the questions will now without doubt present themselves to you—Why should the oil spread so determinately over the water and retain the position thus gained so obstinately? and why should it appear to repel camphor? Unto such questions I might with propriety reply, that to entertain them here is not incumbent upon me, as I have now completed the task I set myself in this paper, by showing that camphor moves, as we have seen, upon water, for the same reason that solid particles occupying a water-surface move when oil is added. To treat such questions is really to take up another subject, and one which includes within its scope the behaviour of oils generally with water when in presence of it—a subject, moreover, which I had reserved for a further communication to you; but rather than leave the matter in hand in a state which may to some appear unfinished, I will trench upon these subjects so far as to make a few general observations thereupon in elucidation of these questions. It is, however, proper that I should premise these observations with a short statement of the prevailing opinion as to the reason of the extensive spread of even minute quantities of oil upon water under favourable circumstances, and their refusal to mix under other circumstances.

According to these opinions, and these are both the popular and scientific ones, the spread of oil upon water is simply the result of gravitation in conflict with the cohesiveness of the oil, and the apparent antipathy which they manifest towards each other, is the result of an exertion of a repulsive property innate in one or the other, or in both. Thus it seems to me that the possibility of chemical reactions being concerned in each of these operations has not been contemplated, and so, as I am persuaded, an important factor in both these problems has been left out of consideration. In opposition, then, to such opinions, I will maintain here that both the spread of oil upon water in thin films, and the apparent repulsion which may be seen to occur between the two, are brought about mainly through the satisfaction of chemical affinity.

I will only now take to task, in a direct way, the idea that oil and water mutually repel each other.

If any one will put a slender stick of some solid fat into water and then remove it so that the lowermost point thereof is about one-twelfth of an inch above the water-line, he will upon due examination find that a portion of water adheres to the fat and joins it to the remaining water. Some fats may be lifted out of water to a much greater distance than this before connection therewith is broken. Now, you will perceive that these effects are quite incompatible with this idea of repulsion; could fats repel water, they would rather depress water when applied thereto than raise it.

A cohesiveness so strong as this can, as I believe, only be explained* by assuming that a chemical combination has taken place between the fat and the water, a combination not of masses but of surfaces, because of the insoluble nature of the product in relation to both the substances furnishing it.

What is true here of fat will undoubtedly be true of the oil it furnishes.

Allowing, then, that oil and water have affinities for each other, these will certainly come into play to a very great extent as regards the oil when a very thin film of it has contact with water, such as obtains when a drop of oil is suffered to extend itself upon water unchecked, and the fact that oils thin out in this way, and so rapidly as they do, upon water, I would attribute in largest measure to successful exertion on their part to satisfy this affinity. Corroborative of the truth of this opinion is the fact which I have ascertained that oils spread far more rapidly and extensively upon water than upon mercury, a substance which as far as we know has not any affinity for them; and in further corroboration of this, oil, as we have already seen, does not spread at all when applied in small quantity to water which is covered with hydrated camphor; still, each of these surfaces—the metallic and the camphoretted—may appear to us as smooth as that of the purest water.

And now applying the knowledge of these results and the deductions they seem to allow us to make to the elucidation of the questions which I have proposed on your behalf, I would maintain that this camphor oil, though in part composed of water, has still an unsatisfied affinity for water by which it is urged to extend itself around in search of it; it occupies firmly the surface it has thus overrun by reason of its internal cohesiveness, its inertia, and its affinity for water.

It forces the parent piece of camphor into movement, because being saturated with camphor there is no unsatisfied affinity existing between

* That this effect is not produced by atmospheric pressure is certain from the fact that the whole of the portion wetted may be open to the air.

them, so each of them—that is, the oil and camphor—can only respond to their affinities for water; to the water therefore they both keep, for its possession they fight. It is a running fight, in which the oil having a motion of its own communicates a part of this to the camphor, and so appears as the pursuer.

Summarizing, now, all that we have here arrived at, by way of emphasizing the points I consider as fundamental to the theory I have proposed, you perceive that I have maintained upon evidence, much of which has been experimentally demonstrated, that the movements described by camphor occupying a surface of pure water, are neither due to the direct impingement of vapour upon such surface, nor yet to any electrical effect, but to the production of a compound of camphor with water, which, being of an oily nature, spreads upon the surface of the water, and, in the act, forces the camphor to describe the movements in question, precisely in the same manner that oils generally, in their flow along the same kind of surface, can urge away from them any solid particles resident thereon. In the actual process, directly that the camphor touches the water there is a considerable but unequal output of this oil therefrom, and as this does not dissolve in the water, nor volatilize, at nearly the speed at which it is formed, it spreads principally upon the water, and retaining for the time possession of all it thus overruns, it urges and keeps the solid camphor away.

As I have already stated, were the production of this compound equal around the camphor, we should not see the camphor move as we have done; but this is in the nature of things impossible, as there is certain to be more of it made at the instant of immersion upon one side of the camphor than upon any other of equal extent, and so an initial movement and direction is given to the camphor. When this direction changes, as it frequently does, the output of oil has become greater upon a different side, or the camphor, in its course, has got into contact with its trail; when all movement ceases, the whole surface of the water, or at least that within a considerable distance of the camphor, has got enfilmed with the oily compound, and the camphor thus becomes oil-bound.

As to the reason why the oil of camphor when in motion, or, indeed, any oil in motion, should thus urge camphor about, I have attempted to show that this is due to the fact that they have no affinity for each other, but that each has an affinity for water, and so they have both a tendency to keep in contact with it—in fact, they are adhesive in relation to the water, but neutral in regard to each other, hence the appearance of direct repulsive effect—a kind of effect, which by-the-way, I believe to be always due to secondary action.

Now, if the conclusions stated above are in the main correct, any substance floating upon a clear surface of water and discharging oil thereon, should describe motion, and motion of the same character as that which you have seen camphor make. Well, this is, I find, precisely what does happen when the experiment is performed.

I rub this small piece of cork with a very little turpentine oil; it has now absorbed this oil, and appears but little different from another piece of cork I have here, which has not been oiled. I place both upon water, and now you can see that while the clean piece of cork remains stationary thereon, the oiled piece moves about in a very vigorous and eccentric manner, imitating the motion of camphor so closely that, except for the difference which exists between the colour of the two (the camphor and the cork), one would take them as they move for the same thing.

Like effects follow when any non-volatile oil is used in place of turpentine. These experiments are surely crucial tests as regards the correctness or otherwise of the theory I have proposed to you.

I will only add to this by stating that, should further research prove that the several deductions I have here made to you are correct, a decisive blow has been given to the popular theory that vapours are directly repellent, as they are emitted in presence of air, from substances at the same temperature and pressure as that of their surroundings*; and also, as I believe, to the theory that a repulsive property is innate in our oils, and that it is, as it were, developed into action whenever water is placed nearly in contact with them. I say nearly in contact, for the contact which ensues on collision of bodies may also cause *repulsion*, but not repulsion in the sense I use it here, viz., that in which it is used and to which it is limited by physicists when they deal with this particular matter.

In this connection I cannot refrain from stating to you my belief that repulsion and its correlative attraction, whether in reference to electricity, magnetism, or the movements of masses in relation to each other, are not direct results indicating the action of two properties, but are secondary ones brought about by and indicating modification of matter.

POSTSCRIPT.

I have lately been successful in getting results which, in the first place, demonstrate that the surface of water is *chemically affected* by camphor, and, in the second place, I got results which completely explodes the current idea that vapours in their emission *drive* solids away from them, as *per se*.

I. Water which has had camphor moving over its surface a long time, refuses to gyrate camphor; its surface acquires a somewhat resinous lustre, being, in fact, more refractive of light than

* Vapours, of course, are always in a repellent condition as they rush into a vacuum.

before, as *I think* (this is, however, for measurement), and such surface *will not allow kerosene or turpentine to flow over it; i.e.*, a drop of either put on keeps in nearly the drop form; in pure water they would flow over instantaneously. I have got the surface to refuse *olive oil* even, a very searching oil though a slow mover. This shows that such surface is a combination of camphor with water; and I am now enabled to fill up a break you would observe in the continuity of my paper. I now show how camphor forms some compound with water, which will not allow oil to flow over it. This compound is not camphor, because camphor is soluble in oil. I think it is probably the hydrate. If it is the hydrate, the surface should, by continued exposure, again rotate camphor, or allow oil to flow over it; and I find that two hours' exposure of a non-rotating surface does restore to it the property of rotation.

II. That vapour does not necessarily repel, seems shown by the fact that cork, on turpentine, or kerosene, is *attracted* by ammonia vapour. Now, ammonia is a substance which, being rapidly evolved—far more so than camphor—should repel cork on turpentine strongly. (Camphor, I may say, and ether, and alcohol, do repel cork on this liquid).

Again: *Turpentine* vapour does not repel cork on *turpentine*, but it repels cork on water; and water offers more resistance to the movements of substances swimming on it than to substances swimming on turpentine.

Clearly the idea that vapour in transit (*molecular* movement) can move masses of matter visibly to us, does not receive any support from such results as these.

I am led to hold by researches here, and by thought on the matter, that the generally received idea that vapour exercises a *direct repellent force*, is *entirely erroneous;* it *appears* to do so, but it in reality forms a compound with the liquid it appears to *repel*. A compound being lighter, or having greater diffusive power than the normal liquid, rolls like a wave away from the *supply*, and carries any dust mechanically with it, giving the *apparent* repulsive effect observed.

Repulsion by direct force of vapour is, I hold, an optical illusion, and one which physicists should long since have exploded by force of pure mathematical formulæ, and not left it as a job for chemists.

I shall in a future paper take the larger subject, that no kind of matter can be visibly repelled while intercepting vapour in transit so long as a common temperature is observed and the pressure is not notably irregular.

Lastly: I get a decided attraction (apparently) of camphor for camphor when this substance occupies the surface of water upon which it has rotated for a time sufficient to give a surface about half charged with the camphor compound.

Art. LXXXII.—*On Osomose, as the Cause of the persistent Suspension of Clay in Water.* By William Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society*, 9*th November*, 1878.]

That certain waters can and do persistently suspend clay is a fact which has been known from time immemorial, and the fact has also been known for a time nearly as long that when alum is added to water thus employed, the clay thereof is first coagulated, then precipitated, leaving the bulk of the water quite clear. This effect of alum has always been attributed to the fact that in a relatively large quantity of water it partially decomposes, producing a nearly insoluble basic salt which, as it precipitates, carries the clay down with it, entangled therewith, an effect which is therefore simply a mechanical one. In the year 1868, however, I showed* that the same effect could be produced chemically. I then brought under public notice the fact "*that several neutral salts having their component parts so strongly combined among themselves as to render their decomposition by clay-water impossible, are individually capable of precipitating clay from suspension in water.*" I further showed that such precipitates re-acquire a property of persistent diffusion, if well washed in pure water;† and I then maintained, and do still maintain, that these salts thus affect clay so suspended solely by the exercise of their affinities for water, by which means the clay is partially de-hydrated, and so has its density increased to such an extent that gravity soon markedly asserts its influence, causing the observed coagulation.

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* *London Chemical News, No.* 435.

† My claim as the discoverer of this effect of neutral salts has, to use a digger's phrase, been "jumped" by several investigators working independently of each other, but all, of course, in happy ignorance of the fact, that it was already properly "pegged out." One of these (Dr. Sterry Hunt, formerly of the Geological Survey of Canada), has even unconsciously followed me so closely and so far as to make the same application of the knowledge of this property of such salts as I did—viz., to the explanation of the cause of the freedom of the oceanic waters from clayey matters.

This theory has been combated by eminent scientists, as will shortly appear; but whether it be true or not, it is certain that the mode of action of such salts is quite different to that by which alum is always supposed to operate, although they have been, for want of due consideration, undistinguished from each other. It is, moreover, certain that clay, so coagulated, is de-hydrated, and the knowledge of the two cognate facts—simultaneous coagulation and dehydration of clay under such circumstances—is, as will shortly be seen, one step towards the solution of the question before us (the cause of the persistent suspension of clay in certain water), as it is thereby shown that clay must be hydrated to an extent at about its maximum in order to manifest this property.

Induced by a knowledge of this fact, I ventured (in the communication referred to) in explanation of this persistent suspension, the opinion that clay can hydrate to an indefinite extent, so that it can even take up in a combined form the whole of the water in which it may be diffused, making a kind of jelly with it, very weak but still having enough consistence to retain in a comparatively fixed state the clay particles of which it is in part composed. But having lately taken careful cognizance of the remarkable fact that particles of clay when persistently in suspension are as persistently in motion (describing the so-named Browinian movements), I have now perceived that hydration of clay never does occur to this extent; these movements of such particles proving the presence of free water in their neighbourhood, which, of course, is against the theory of indefinite hydration, and so left the question as to this persistent suspension of clay still to me unsolved.

Upon casting about in our scientific works and periodicals for a solution of this phenomenon, I came across various theories professing to account for it. Notably, one by Prof. Jevons, ascribing it to electricity; one by Dr. Hunt, ascribing it to the viscidity or cohesiveness of pure water; and another by Mr. Dancer, who attributes it to the effect of heat unevenly distributed. Upon mature deliberation I concluded that each of these theories is as unsound as the one which I had discarded, and it then occurred to me that in the action of *Osomose* we have the solution sought for, *i.e.*, the cause of the persistent suspension of clay, and after a careful consideration of this view of the case, I am so impressed with the idea of its accuracy that I now venture to submit it for your criticism.

In order to present this view to you in as favourable and clear a light as possible, I will first briefly state the principles of *Osomose*.

Any colloid (that is, a substance which cannot be crystallized, and which, though insoluble in water, is capable of largely combining with it) has the property of allowing water to pass through it, and crystalloids

also, but to a less extent than water, that is, for equal times of contact therewith.

When, therefore, a colloid, say of albumen, is formed into a stiff diaphragm, with water on the one side and an aqueous solution of a crystalloid upon the other side, having about the same height as that of the water, the level of the liquids is altered by their unequal diffusion through the diaphragm, that of the water is gradually lowered, while that of the saline solution is raised, until after the lapse of a day or two a very marked change of level is observable.

These effects are far greater in the case of weak saline solutions than strong ones, and for alkalies and acids than for salts. It is the mechanical, the lifting effect observable in the apparatus described, that I have noted for the elucidation of the phenomenon of clay suspension.

I make the application as follows :—Exchange the fixed diaphragm of albumen for a highly elastic one of the same material, and for the *change of level* before observed in the two liquids there is a change in the *position* of the diaphragm. The albumen will move in a mass transversely away from the saline solution.

Hence we may be certain that were a fragment of this diaphragm, especially a minute one, placed in a liquid containing some salt unevenly distributed, such fragment would also move, and move in the same direction as the diaphragm itself should.

Again, we may be equally certain that we should obtain similar movements by charging the albuminous fragment with a salt *unequally*, and placing it in water, pure or nearly so. Lastly, movements of a similar nature, but not so rapid, would ensue, were these fragments charged with the salt *equally* throughout, as some part of their exterior could scarcely fail to be of more angular construction or to be more porous than the remaining parts, and so would take up water at a greater speed than the other parts, thereby causing a recession of the fragments from the liquid at such points of contact, precisely in the same way that I have shown the movements of camphor upon water are produced.*

Thus by progressive changes in the common form of dialytic apparatus, we have at last an apparatus of this kind consisting of a vessel of pure water in which are minute homogeneous fragments of albumen, evenly charged with a salt, one by which all the motion produced by dialysis thereby is communicated to the dialyzing material itself, that is to the minute albuminous fragments. The same result would of course follow were the albumen pure and the water saline.

* *Vide supra*, Art. LXXXI.

It is therefore quite certain that any substance capable of dialyzing will, when swung clear of all attachments in pure water, describe movements of great persistency which are due to osomose, and in order to complete the evidence which is yet required to show that osomose is the cause of the persistent suspension of clay in water, it only remains to be shown that this substance (clay) is capable of dialyzing.

For this purpose I adduce Prof. Graham's opinion of the mode in which osomose is effected (an opinion in which I fully concur). This able chemist (the discoverer, by the way, of osomose) attributes it entirely to the exertion of chemical affinity. Any dialyzing diaphragm having water on the one side and saline water on the other, is, he holds, constantly absorbing, that is combining with water towards the side which is in contact with water alone, and giving it up to the other side, that is, to the saline solution there.

Thus it appears that any substance which, while insoluble, or nearly so, in water, can still weakly combine with it, and in various proportions, is competent to dialyze.

Now, clay is most certainly such a substance; it hydrates readily, and is as readily de-hydrated, that is in part, and the proportion in which it hydrates manifestly varies, and under the very conditions it is necessary that it should do so for my argument, that is, as placed in pure water and saline water, as is manifest to the eye even when clay in water is coagulated by salt.

Indeed, Prof. Graham has shown that porous earthenware dialyzes; he, however, attributed this property to the alumina present therein; but I fail to see how alumina could be liberated from the earthenware in his experiment. I should rather attribute the effect he observed to that portion of the ware which had been hydrated to clay.

It is therefore, I think, now clearly shown that clay is capable of dialyzing, and so is competent, under conditions already named, to describe movements due to osomose.

The principal cause, then, if not indeed the sole cause, of the persistent suspension of clay in water, is undoubtedly *motion communicated to it by osomose;* and as osomose is the more rapidly produced in saline solutions the weaker they are, and further, as the motion thereby derivable should be applied with greater effect to clay particles the more hydrated and, consequently, the lighter they are, it follows that suspension of clay in water will be the more persistent the less saline the water is—a fact which, as you may remember, I have long since demonstrated.

In water saline to a certain extent, clay particles by de-hydration acquire a density too great to allow of their remaining sensitive to the motion proper to osomose; they therefore coalesce, and gravity soon asserts itself.

There is, perhaps, one point in respect to this, about which you may require further information ere you would be prepared to give an opinion respecting the accuracy of my theory. It may be asked whether, in all instances of persistent clay diffusion, there is sufficient soluble saline matter present of such a nature, and which is, besides, so unevenly distributed, as to enable dialysis to be carried on to the necessary extent?

In regard to this, I would reiterate the statement which I have made, that dialysis is best produced by very weak saline solution, and I would, besides, remind you that by far the most effective solutions for this purpose are those of the alkalies, and it is precisely matter of this kind, which, as it happens, is certain to be present and unequally distributed in any clay water we may ever prepare.

In all clay, as you are aware, some alkaline matter is present, and in such a form that it gradually passes into solution. Again, ammonia can, as we know, scarcely be excluded from the water through which clay may be diffused, and it signifies not where the alkalies are, whether with the clay or the water, so long as they are not equally diffused throughout both.

In this connection it is proper to note the fact which has been recently discovered*:—"That the power which water possesses of sustaining clay in suspension is increased by the addition of small quantities of the alkalies or their carbonates," and that water, whose power of sustaining clay had been destroyed by an acid, had this power restored in great measure by any of the alkalies. Now precisely the same kind of thing would happen in the case of albumen, and conversely salts in large quantity retard or prevent the alkalies acting in this manner. The analogy therefore between clay and albumen in respect to my subject, is obviously of so wide and general a character that we may safely assume them to be alike capable of assisting in osomotic action and its results.

In conclusion, I would state that I have thus singled out the persistent suspension of clay for explanation in place of the persistent suspension of substances of a like nature generally, because the question of clay suspension is to me of particular interest as being one I have had in my mind for a long time past, and I obtained by experiment results thereon which I am persuaded are of some value in regard to its settlement.

Granted, however, that this attempt of mine at the explanation of the persistent suspension of clay is a successful one, the principle thus involved is so easy to make a general application of, to the explanation of those

* Suspension of Clay in Water, by William Durham, F.R.S.E. Read before the Physical Society of Edinburgh, 28th January, 1874.

numerous cases which are analogous to the present one, that I need not do more than point out to you the fact that such a kind of application would then be both right and necessary to make.

Art. LXXXIII.—*On the Nature and Cause of Tomlinson's Cohesion Figures.*
By William Skey.

[*Read before the Wellington Philosophical Society, 9th November*, 1878.]

It has long since been known that when any oil is suffered to flow on water in very thin films a beautiful play of colours is produced; but it was not till the year 1868 that it was observed certain figures were at the same time formed at a rate and of a pattern varying according to the kind of oil used.

These figures are made up of small annular spaces, set in a ground of a different shade, and are known as Tomlinson's cohesion figures, after Prof. Tomlinson, the discoverer of them. They are employed by Dr. Moffat, lecturer on chemistry, at Glasgow, to base thereon a system of olegraphy (that is, one by which oil may be identified), and it is their precise nature and more immediate cause which I now wish to discuss before you, as I have been led by recent investigations of mine upon oils, to believe that neither the one nor the other have been heretofore in the least apprehended, and this, because the possibility of chemical reactions being involved in the production of these figures has not been contemplated.

Thus, as far as I can gather from the statements of Prof. Tomlinson and Dr. Moffat (the only scientists who have, within my knowledge, investigated this subject), the annular spaces are "perforations" or "holes," bottoming, as it necessarily follows, upon the water-surface used, and set in a ground which is presumedly formed of oil. Now I think the annexed account of observations made by me, will show to you very clearly that all this is directly opposed to the facts of the case.

First, then, in regard to the annular spaces (the so-termed "perforations" or "holes"). A careful inspection of them showed me that the surface in these parts is not at all depressed as compared with that of the rest of the patterns, but is, on the contrary, *raised*, either in flat or round-topped hills according as these spaces are of large or small extent. I further found that the liquid occupying these parts—that is, the hills—burns completely away, and without the least spluttering, showing that it is an oil.

Secondly, as to the ground of these figures, *i.e.*, the part in which these annular spaces or markings are set. I found that when a small quantity of any oil is gently placed thereon it does not spread to any notable extent, but keeps nearly to the drop form; and it was further manifested to me that this part breaks into angular fragments, which are possessed of such rigidity that they keep to a tabular form no matter how they are dashed about. Now, as oils indiscriminately flow over oils, and as none of them can indurate to such an extent as would determine angular shapes to their fragments, it is clearly demonstrated that this part, *i.e.*, the ground of the pattern, is not an oil.

The current idea, then, as to the nature of this part of the figure, being fallacious, it is necessary that we should adopt another.

What this ought to be, a full consideration of the case will, I think, clearly show. Thus, owing to the great proneness of oils generally to oxidize to substances of a resinous nature when exposed to air, it is certain that in no instance do we, for the production of these figures, operate with an oil that is not, to a small extent, charged with such matters; and further, it is also as certain that the quantity of resinous matter therein must be very largely increased by the time that any cohesion figure made with it has passed to its final form. It being, therefore, undeniable that resinous matter forms one of the principal constituents of the cohesion figure in its ultimate condition, the conclusion forces itself upon us that of such matters is the material of their ground alone composed. This is really the only alternative, as it is one which meets all the requirements of the case. So attenuated, indeed, and so exposed are the thinner portions of these figures, and so rapidly is the kind of change indicated wrought upon oil under these conditions, that it is only reasonable to conclude that these portions are wholly composed of resin, to the exclusion consequently of any trace of oil.

As being corroborative of the truth of the supposition that the presence of resin in the cohesion figures plays an important part in their production, I would inform you that the addition of about ten per cent. of resin to a good oil very much quickens the production of cohesion figures, and also passes them through their various phases to the ultimate figure with a speed which is far greater than is to be observed in the case of the oil.

And now I think the foregoing statements of facts and observations may be fairly held to demonstrate—

1st. That the annular spaces or markings of Tomlinson's cohesion figures are not *depressions* but *protuberances*, not holes but hillocks, and are not composed of water, but of oil.

2nd. That the plane part of these figures the ground as it were of the pattern, is not oil (as heretofore quiescently allowed), but either a

highly resinoid substance or a pure resin according to the time it has been exposed to the air.

It only remains for us now to discuss the subject of the *cause* of the production of the figures in question, and for this I need not do more than point out to you, that if the nature of these figures is as I have just described, their cause—that is of course their more immediate cause—can be no other than the oxidation of a portion of the oil employed to produce them, and the aggregation of the remainder into annular patches to form the markings which characterize them.

How oil and resinous matters do thus dissociate, is a question which is scarcely within the scope of this paper to discuss. It is, however, one of such interest, and is moreover so intimately connected with my subject, that I cannot refrain from doing this in a brief manner, although to do so somewhat trenches upon a subject which I intend soon to treat of in a further communication to you.

According to ideas now in vogue, one word would be sufficient to name in answer to this question. Why do these two substances dissociate? And that word is repulsion. The resinous parts of these figures would be held in accordance with these ideas to repel the oily part.

But from several observations I have recently made, I have reason for asserting that this appearance of repulsion is at bottom due to the effects of cohesion. One of these observations is that greasy matters generally, contrary to present scientific and popular opinion, instead of repelling water, adhere thereto when placed in juxtaposition with it.*

The phenomenon of dissociation then has, I consider, to be explained by a hypothesis in which the property of cohesion only has to be taken into account, and I would form it as follows:—Oil has a certain degree of cohesion for itself, also for water; but the products arising from its oxidation have a greater cohesion both as among themselves and for water, and it is in direct proportion to the degree in which they are chemically removed from the oil which furnishes them; until, as the final products of this process are reached, a notable affinity for water (that is an intense cohesion) developes; but this great cohesion for water on the part of such products is attained only by a corresponding loss of cohesion between them and the oil, that is the unaltered or less altered oil. These products therefore have a constant tendency to monopolize the surface of the water upon which they are formed, and the unaltered or but slightly altered oil,

* If solid grease is placed in contact with water, the water-surface in the immediate vicinity of the grease is not depressed below the general surface of the water; and if the grease is lifted just above this surface, the water in its vicinity is also lifted above it, showing very clearly that the two substances *cohere.*

in consequence of this, exercises the property of adhesion to the greatest extent *in respect to its own parts*, hence it coalesces in those annular elevations which form the principal feature in the cohesion figures of Prof. Tomlinson.

I will conclude this paper by informing you that I consider this change of oil into resinoid substances helps largely to produce those rapid changes of colour which oil exhibits when exposed to the air upon a surface of water; indeed, it appears to me that the effect of those chemical changes which must take place in certain liquids when exposed to the air or brought into contact with each other, has been ignored by those persons who have hitherto investigated the subject of the flow of liquids upon each other.

V.—GEOLOGY.

Art. LXXXIV.—*On the Geological Structure of Banks Peninsula, being an Address by* Prof. Julius von Haast, PH.D., F.R.S., President of the Philosophical Institute of Canterbury.

[*Read before the Philosophical Institute of Canterbury, 7th March,* 1878.]

Gentlemen,—Being called again by your vote to the honourable position of presiding at your meetings, the agreeable duty devolves upon me to address you to-night at the opening of the session 1878. It has been the custom of your newly elected President either to offer you a review of the progress of science in New Zealand, to treat of some special branch of scientific research, or to lay before you the results of his own investigations into the zoology, geology, or ethnology of these interesting islands.

With your permission, I shall follow the latter course, and venture to offer you some remarks upon the geological features disclosed to us by the piercing of the Christchurch and Lyttelton Railway Tunnel, a gigantic work, ever creditable to the energy and forethought of the Provincial Government of Canterbury in those days when only a small population had settled here, and the work to be undertaken was looked upon by many as far beyond our means. I shall preface the description of the tunnel, of which a section on a scale of one inch to twenty feet hangs at the wall, by some observations on the genetic history of Banks Peninsula, and upon the remarkable system of dykes, by which the older caldera walls have been intersected.

When standing on the Canterbury plains the most striking feature in the landscape is Banks Peninsula, rising so remarkably above the sea horizon, that its regular form at once attracts our attention. First we observe a series of mountains, of which the summits are all nearly of the same altitude, which, as it appears to us, as far as our eye can follow their outlines, form nearly a circle, from which a great number of ridges slope with a nearly uniform gradient towards south, west, and north. Above them, in the centre, stands conspicuously a higher truncated mountain with precipitous escarpments, assuming, according to the position of the traveller, a different aspect. The rim of the lower mountains in front rises to an average height of 1,600 feet, whilst the central system attains an altitude of 3,050 feet. On reaching Banks Peninsula from the sea, we find that several

deep indentations, forming splendid harbours, enter far into the outer rim of the mountains, passing for a considerable distance along the higher central range. Similar indentations are also found to exist towards the Canterbury plains, but they have either been already filled by alluvial deposits forming fertile valleys, such as the Kaituna valley, or they appear in the form of a lake (Lake Forsyth). In examining the nature of the rocks of which the system under consideration is composed, we find that, with the exception of a small zone at the head of Lyttelton Harbour, the whole is composed of volcanic rocks; that the deep indentations are ancient crater walls, so-called calderas, into which a channel with precipitous walls, the barranco, leads; and that they consist of a series of lava streams, with agglomerates consisting of scoriæ, lapilli, ashes, and tufas interstratified with them. These beds have all a qua-qua versal dip, that is to say, they all incline outwards from the centre of the cavity. The higher mountains in the centre consist also of volcanic rocks of a similar composition, which appear either horizontal or, when the direction of the lava-streams composing them can be ascertained, are found to flow into the calderas previously formed, from which we can at once conclude that they are of younger origin. Finally, we find mostly in or near the centre of these deep cavities, or calderas, either a small island or a peninsula stretching so far into these harbours. They consist also of volcanic rocks, having been preserved above the last centre of eruption. This last sign of vulcanicity is on a smaller scale than the previous ones. The whole of Banks Peninsula, measuring along its longest axis from north-west to south-east, has a length of 31 miles, with a greatest breadth of 20 miles, and if we do not take the numerous indentations into account, it has a circumference of 88 miles, which corresponds closely with that of the base of Mount Etna.

Having thus given an outline of the general features of the volcanic system under consideration, I shall now proceed to offer a short history of its origin.

The oldest rocks in Banks Peninsula form a small zone of palæozoic sedimentary strata, possessing a slightly altered structure, many of them forming beds of chert, others, peculiar light-coloured brecciated schists; however, sandstones and dark clay-slates are also represented. This zone has a north and south direction, and reaches to the southern watershed of McQueen's Pass, which leads from the head of Lyttelton Harbour to Lake Ellesmere. Near this pass, slates appear as high as 600 feet above the sea-level. On the western slopes of Castle Hill, the south-western cotinuation of Mount Herbert, 2,900 feet high, which rises so conspicuously above Lyttelton Harbour, they reach an altitude of nearly 1,000 feet, where they are overlaid by the older lavas, forming the Lyttelton Harbour caldera.

Thus a sub-marine hill stood here in the young mesozoic sea, of which portions of the summits and the slopes were gradually covered by agglomerates and brecciated beds. These beds were formed during and after the eruption of quartziferous porphyries, of which here and there portions of the *coulées* have been preserved. Some of these quartziferous porphyries resemble in every respect those from the Malvern Hills and Mount Somers. They are also accompanied by pitchstones, porphyritic from the presence of numerous well-formed crystals of sanidine or glassy felspar, and occasionally of garnets. Other portions of the quartziferous porphyries, as for instance, the whole *coulée* of which Manson's Peninsula is formed, have a rougher, more trachytic matrix. They are full of grains and small crystals of white greyish or smoky quartz. The brecciated beds have a hard felsitic matrix, and the angular fragments of rock enclosed in them belong to a variety of eruptive rocks of many colours, and of different texture, often forming a rock of striking character. They appear conspicuously on the summit of Gebbie's Pass, having been washed into cliffs of picturesque forms, and covering the palæozoic sedimentary beds from one side of the pass to the other. After the formation of the brecciated agglomerates, new eruptions of acidic rocks took place, now in the form of rhyolites, the highly liquid matter reaching the surface through broad channels, of which one has been preserved as a large dyke, forming a beautiful section on the northern side of Gebbie's Pass, not far from the summit. The dyke is here about 100 feet thick, half of which is formed by the central portion, consisting of a whitish rhyolite with a fine laminated structure, breaking in prismatic blocks; the rest on both sides, where in contact with the agglomerates, has cooled more rapidly, and has assumed the character of an obsidian. This obsidian is greenish or brownish-black, very brittle, and imperfect crystals of sanidine are enclosed in it. This dyke can be traced for a considerable distance upwards. Where overflowing and covering the agglomerates it forms the highest peak on the western side of Gebbie's Pass, well visible from Lyttelton Harbour. The rock here is divided into small pentagonal columns, with a vertical arrangement; lower down the pass, the same *coulée* has a tabular structure.

The oldest crater, of which the principal boundaries can be traced at the present time, is the Lyttelton Harbour caldera, having a general diameter of about two miles, the centre of which is situated a little to the south of Quail Island. The general structure of this crater, even before the Christchurch and Lyttelton Railway tunnel was entirely pierced through, could easily be made out by studying the numerous sections exposed in many directions, and by ascending the steep escarpments of the caldera wall, where a succession of streams of stony or scoriaceous lava, interstratified

with beds of agglomerates, ashes, tufas, and laterites can be traced to the very summit. Still clearer sections are open to our inspection if we follow the barranco or entrance into the harbour, forming sometimes vertical cliffs of considerable altitude, and where the whole series of beds can easily be followed. However, the most interesting and complete insight was obtained in the railway tunnel passing through the caldera wall, and of which, as the work gradually advanced, I prepared a careful section. The succession and dip of the lava streams and the intervening beds can also be made out by following the slopes of the ridges between the deep valleys washed out on the outer side of the crater wall, where it will be found that the lava streams forming the lip of the crater have generally a slighter inclination than those lower down, the dip of the upper ones being only nine degrees on the average. In the tunnel the dip is greater, an inclination of twenty degrees not being uncommon. It is evident that the building up of such a huge system during numerous eruptions, often of great magnitude, could not be accomplished without a great destruction of portions of the beds previously formed taking place, the point of eruption in the crater shifting continuously about the centre. If, at the same time, we examine the lava streams and the interstratified agglomerate and ash beds along the water's edge, we have to come to the conclusion that all the eruptions by which the caldera wall was formed from summit to bottom, occurred under the same physical conditions.

Examining into the formation of the Lyttelton caldera, and beginning our observations in the harbour, we find that many lava streams have been preserved which have cooled in their ascent; others lie horizontal for a short distance, and are then seen to descend, conforming to the gradient of the underlying lava streams or agglomerate beds. In many instances we have also clear evidence that considerable destruction of the beds previously formed had taken place before new streams flowed over the lip of the crater, or before beds of ashes, scoriæ and lapilli, were deposited anew. The tunnel section in this respect is also very instructive. Thus, in course of time, the great crater wall was formed, rising to an altitude of nearly 2,000 feet, and having a diameter of more than five miles at its crest. It is clear that close to the vent, from which scoriæ and ashes were thrown out in large quantities, the greatest thickness of the agglomerate beds ought to be formed, and this, in fact, is the case, as the largest beds, having sometimes a thickness of several hundred feet, are situated within the inner side of the caldera wall. The lava-streams here between these agglomerates are irregular in their direction, and mostly of small dimensions. The more we advance towards the outer slopes of the caldera wall, the less frequent become these agglomeratic or tufaceous layers, whilst the lava-streams,

which towards the centre have the greatest bulk, and are very stony and compact, become now gradually more and more numerous, but of smaller size and more porphyritic or scoriaceous, according to the laws by which the flow, dimensions and cooling of the lava-streams are regulated. It is, moreover, evident that many of them, owing to want of material, scarcely reach half way down the slopes of the caldera wall, that others rapidly thin out, and that many which, for some distance after flowing over the lip of the crater, had been of large dimensions and stony, become, long before its outer edge is reached, thin and scoriaceous, so that here streams of five feet in thickness are not uncommon. Although the tunnel does not offer us the necessary data to judge of the breadth of the lava-streams, we have for that purpose ample evidence in Godley Heads, the sea-wall near Sumner, and many other localities. There are streams which are 500 feet broad, others only 30 to 40, but all without exception are somewhat scoriaceous on the bottom, where the lava flowing over cold ground cooled more rapidly. In many instances this is well exhibited by the existence of a small bed of laterite, a brick-red coloured rock, sometimes only a few inches thick, which doubtless was a layer of soil on the decomposed upper portion of the lava-stream or agglomerate bed exposed for a considerable time to atmospheric action before the new eruption took place. The lava in the larger streams, and in its central portion principally, very stony and of a blackish colour, gradually becomes, as we approach the surface, more porphyritic, with a more open texture, and assumes pinkish or lilac tints, till it changes into scoriæ. The decomposition or alteration is here often so great that it is impossible to trace the top of the line of contact between the surface of the stream and the bottom of the overlying bed, both forming a layer of coarse agglomerate. In other instances the rough, uneven scoriaceous surface of the lava-streams has been well preserved, the hollow spaces being filled up by ashes and ejecta, in which case they resemble many of the recent lava-streams which I examined in Mount Vesuvius and Mount Etna shortly after they had issued from the crater.

The lava of which the caldera wall under consideration has been built up, consists of basic rocks, changing from a dolerite to a fine-grained basalt. Some of the lava-streams, however, as previously pointed out, show also a remarkable difference in the structure of the rock of which they are composed, the central portion being a compact basalt with a few crystals of augite, basaltic hornblende, labradorite, whilst the upper portion consists of a lighter coloured porphyritic dolerite, sometimes so replete with good sized crystals of labradorite that the greater portion of the rock is formed of that mineral.

Returning to the orifice or orifices from which the material for the formation of the caldera wall was ejected, and to which also the numerous dykes, mostly having a vertical position, intersecting it, can be traced, it appears that the principal focus of eruption was situated a little to the south-west of Quail Island, as the greatest portion of the dykes radiate from here, and the eastern and southern sides of Quail Island, and the shores near Charteris Bay, are formed of tufaceous agglomeratic and brecciated beds, in which a number of angular blocks of rock are enclosed, having all a very bleached appearance.

It would go beyond the limits of this address were I to follow the further genetic history of Banks Peninsula in all its details. I can, therefore, only indicate here in a few words how the whole, in course of time, has been built up. Simultaneously with, or shortly after, the Lyttelton caldera, the Little River caldera, of which only a small portion remains, was formed in the same manner. The formation of the largest of the whole series, the Akaroa caldera, is next in age, which, with the exception of a small portion of its northern rim, is perfectly well preserved. After their formation, new eruptions, and of a different form, took place south of the Lyttelton caldera and north of the Little River and Akaroa calderas, during which the highest portion of Banks Peninsula was built up—Mount Herbert, 3,050; Castle-hill, 2,900; and Mount Sinclair, 2,800 feet; only portions of the craters of these younger systems are still preserved, but easily recognized when standing on the summits of these mountains. The southernmost portion of the Lyttelton caldera was partly destroyed or covered by lava-streams belonging to the Mount Herbert system, also of a basic (basaltic) nature, of which a whole series flowed into it, now forming the huge spurs descending from the summit of Mount Herbert into the harbour between Charteris and Rhodes Bays. The last eruption, of a submarine character, took place in the centre of the Lyttelton caldera, by which Quail Island was formed.

I shall now proceed to offer you some observations on the system of dykes, which are so well developed in the Lyttelton caldera. The most striking facts in connection with the system of dykes of the caldera, and to which I have devoted considerable attention, are their size, longitudinal extent, and constancy in direction. From the researches of numerous observers, it has been proved that all the dykes of Mount Vesuvius and Mount Etna do not extend much beyond the centres of eruption, so that they advance only a short distance, and, rapidly thinning out, soon disappear, a fact which my own observations along the crater walls of both mountains have amply confirmed. However, I have no doubt that other volcanoes similar in construction to Banks Peninsula, and differing as considerably from

these two European volcanic mountains, will be found to possess their systems of dykes developed in the same manner. During a number of years, it has been well ascertained by me that the dykes radiating from the several centres of eruption situated not far from each other, continue in many instances without notable interruption from the former mouth of the crater to the outer slopes of the caldera, where they disappear below the sea, or under the deposits now forming the Canterbury plains. Very often the principal dykes rise nearly 2,000 feet above the sea level. They are well visible from the harbour to the summit of the rim of the caldera wall, above which, in some instances, they stand prominently as a wall, often six or eight feet high. Where proper measurements of the same dyke can be obtained for a long distance, it has been found that generally, as it advances towards the outer circle, it diminishes in breadth; however, in other instances this is not the case, as repeatedly I have found some which, after narrowing on their outward course, considerably enlarge again before reaching the foot of the caldera. Thus to give a few examples, the large dyke of trachyte, which is crossed in the railway tunnel, about 29 chains from the Heathcote end, is first seen west of the town of Lyttelton, near Naval Point, where it is nearly 40 feet thick. On the summit of the caldera wall, not far from the top of the Bridlepath, it has narrowed to 23 feet 9 inches, after which it gradually gains in proportion, so that in Thompson's quarry it has enlarged to 26 feet, a breadth which it still has in the tunnel. A mile beyond the quarry the spur along which its course can be followed runs out in the Heathcote valley, where it disappears below the Loess.

Two remarkable dykes, reaching the summit of Dyke Hill, about 2,000 feet high, west-south-west of Castle-hill, are very conspicuous. They both project boldly from the mountain, with a space of 35 feet between them. The eastern one is 18 feet, and the western 12 feet broad. Two similar dykes exist on the opposite side, and run up the caldera wall behind Raupaki. To mention a few others, there are some important dykes south of Dyer's Pass, which, after crossing Manson's Peninsula, are again met with at Ohinitahi (Governor's Bay), and of which several, after ascending to the very summit of the caldera, reach to the foot of the peninsula near Cashmere, being extensively quarried in different localities along their course. These dykes, like many others which cross the caldera wall towards the Canterbury plains, mostly all radiate from a point lying in the centre of the bay, formed by Manson's Peninsula on the one side, and Potts' Peninsula on the other, both of which consist of quartziferous porphyries, and between which this newer focus has been formed after the greatest portion of the caldera wall had already been built up. There is also the large dyke which crosses

the Lyttelton-Sumner road at right-angles, on the very summit of Evans Pass, and which is repeatedly passed by the road winding in and out of the different bays before reaching that pass. It can be followed to Taylor's Mistake. Everywhere along the sea cliffs at and near the entrance of Lyttelton Harbour, numerous dykes, mostly all in a vertical position, can be seen pointing towards the centre of that harbour. A few, however, stand in a slanting position, and others have a tortuous course. As one of the remarkable changes which some of the dykes have undergone since their formation, I may also mention one which is well exposed in the sea cliffs at Ohinitahi, Governor's Bay; here a dyke of domite, about nine feet broad, crosses in a nearly vertical position the so-called trachyte sandstone deposited on the slopes of the quartziferous porphyry. After its solidification, a new fissure, about three feet broad, has been formed parallel to its direction, and running along its centre, which has been injected from below by domitic matter, but slightly different from the former; however, instead of continuing to the top of the cliff, about twelve feet above the sea level, the dyke is seen to turn from its vertical to a nearly horizontal position, and to thin out considerably at the same time, disappearing altogether when it touches the side wall of the bed-rock. The older dyke, above this change of direction, is considerably shattered and broken.

Before proceeding, it will perhaps be useful if I offer a few remarks on the causes which led to the formation of these remarkable dykes. I consider this the more important, as nowhere, as far as I am aware, do they exist in such great numbers, nor do they possess such a large longitudinal extent, as in the volcanic system under consideration. It appears to me that the immediate cause of the formation of a radiating system of dykes may be traced to the choked-up vent or chimney of a volcano, the mouth of which, after an eruption of considerable dimensions, is thoroughly filled up, either by its sides falling in, by the cooling of ascending lava-streams, or by both causes combined. When, from abyssological origination, masses of steam and gases have collected below this vent, and new matter is ready to be erupted, an enormous effort of nature will be necessary to clear out the old, or form a new chimney, which cannot be accomplished without a series of violent earthquakes, succeeded by an enormous explosion, by which the mouth of the volcano is cleared out or newly formed, and of the magnitude of which we can scarcely form a conception. A similar effect, on a gigantic scale, must have been produced repeatedly by the compressed masses of gases and steam during the formation of the Lyttelton caldera wall, when the upper portion of the closed-up volcano was not only removed, but vast quantities of ashes, scoriæ, and lapilli were thrown out, together with lava-streams which flowed in various directions. Before, or during these

eruptions, molten matter in a high state of fusion generally rushed up in the fissures which had been formed at the time, radiating from the focus like the spokes of a wheel. An examination of these dyke rocks will show at a glance that most of them are quite different in composition and character from those of which the lava-streams have been formed. The latter, as already explained, with one notable exception,* all consist of true basic rocks—basalts often assuming a doleritic texture, the dyke rocks being generally acidic, having either the composition of a trachyte or domite. We are able to judge of the more or less high state of fusion in which the molten matter ascended the open fissures from the effect produced on the walls on both sides. The trachytic matter forming the dykes, which are principally developed on the eastern side of the caldera wall, has evidently been in such a condition that it could exercise a most powerful effect on both walls of the fissure, the rocks often, for several inches, being changed to tachylite, a peculiar basic volcanic glass, quite distinct from obsidian. This change in the character of the rock is most observable when the dykes pass along tufaceous or agglomeratic beds. Here the reddish or light purple rocks have been altered to a black vitreous mass, containing small crystals of felspar. The domitic dykes, mostly confined to the western half of the caldera wall, seem not to have exercised such a great influence as the former, as in most instances the walls on both sides of the dykes are only slightly hardened. However, there is no constant rule; large dykes, as for instance the huge domitic dyke at Governor's Bay, running for a considerable distance parallel to the coast, and forming such a conspicuous object along the picturesque beach road lately constructed, have scarcely made any alteration on either side, whilst smaller dykes of the same rock, only a few feet in thickness, are sometimes accompanied by a well-defined selvage of tachylite. The same may be said of the basaltic dykes, of which, however, by far the greatest part has caused no visible alteration along the walls on either side. The trachytic varieties,

* This exception consists of a trachytic lava-stream of considerable size, and having an average thickness of eighty feet, which is interstratified between two others of a basic character. This peculiar stream occurs between Lyttelton and the pass to Sumner. It is the only trachyte lava known to me as having flowed from any of the different centres of eruption of Banks Peninsula, all the other acidic rocks, as I shall show in the sequel, having been ejected into fissures of more recent date. This lava-stream consists of a white vesicular trachyte rich in quartz, resembling closely some of the domites of the Auvergne, from which, however, it is distinguished by its larger amount of silica, although it approaches it again in its considerable percentage of potash. A vertical dyke, about eight feet thick, of a peculiar flaky silky trachyte, passes through this lava-stream, narrowing, however, in its upper portion. Although this acidic lava is rather soft and friable in small pieces, it has nevertheless resisted the disintegrating agencies at work far better than the hard basaltic lavas and agglomerates in its neighbourhood.

of which most of the dykes on the eastern side of the Lyttelton Harbour consist, are formed generally of a peculiarly lustrous and flaky rock, sometimes vesicular, with small crystals of sanidine. This rock has a light greyish colour, and its small cavities are lined by sphærosiderite. On both sides of the dyke the rock is generally tabular—parallel to the direction of the flow, and is massive in the centre with polyhedric joints, of which the principal ones appear at right angles to the flow. There are also a few trachytic dykes, principally small ones, where the sides, for half an inch to one inch, consist of a rather brittle obsidian, doubtless the effect of rapid cooling. Some very thin thread-like dykes, about one to two inches thick, consist entirely of that peculiar form of acidic volcanic rock.

In studying the position of the dykes it becomes manifest that they have been formed at different times; however, the altitude of their uppermost portion does not indicate their age. I have no doubt that many of them, which scarcely reach above high water-mark, are not older than others of the same petrological nature, which reach to the very summit of the caldera wall. In the present state of our knowledge it is impossible to solve this interesting question in all its bearings, and I can therefore only suggest that dykes containing rocks of exactly the same lithological character have most probably been formed during the same eruption. It is also evident that a number of dykes were formed long before the whole of the caldera wall was built up, and that they were partly destroyed during one of the next eruptions. One clear instance of the occurrence of such older dykes is to be found near Cliff's Cove in Lyttelton Harbour, where several trachy-doleritic dykes were injected when the rest of the caldera wall was at least 1,000 feet lower than at present. They pass through a basaltic lava-stream, which latter was afterwards partly destroyed along with them, the whole possessing now nearly a straight surface, upon which a large bed of agglomerate has been deposited. However, what is of the greatest interest in the history of the volcanic systems under consideration is the predominating acidic character of the dykes when compared with the basic lava-streams. In Vesuvius and Etna all the dykes are formed by the same kind of rock as the lava-streams are composed of, but they are generally more compact, having, as Lyell suggests, cooled and consolidated under greater pressure. It is evident that they owe their existence to the same subterranean efforts by which the lava-streams were ejected from the mouth of the crater, the fissures in which they were formed being evidently filled up from the same focus, and about the same time as the eruption of the lava-streams took place. But such a simple process cannot be admitted for the greater portion of the dykes of Banks Peninsula, which must owe their existence to paroxysmal perturbations in the earth's crust, distinct from

those during which the caldera walls were built up. It is evident that a great portion of the lava-streams and agglomeratic beds which once formed the crater of the volcanic system of Lyttelton Harbour, must have been blown away, or at least removed during one of those violent outbursts of subterranean forces necessary to clear the choked vent of the volcano, similar to those by which in recent times the upper portions of active volcanoes have repeatedly been destroyed under the eyes of the trembling population in the neighbourhood.

For an explanation we might go back to Durocher's views, that all igneous rocks, even the most modern lavas, are derived from two distinct magmas which co-exist below the solid crust of the globe, each of them occupying a well-defined position. According to this distinguished French chemist, the uppermost portion is occupied by the acidic magma, which, besides being of lighter specific gravity, possesses a larger amount of silica and less iron oxyde than the other or basic magma. From the upper layer the granites, porphyries, and trachytes, according to his views, are derived, the zone of contact producing rocks of an intermediate character, such as trachydolerites. If this theory is correct, we have to admit that not only the dyke rocks were injected in rents formed during earthquakes, or immediately before volcanic eruptions had taken place from the opened chimney of the volcano, but that in each case the molten matter was furnished both from the upper and lower stratum of incandescent matter below the hard crust of the globe. There is, however, one great difficulty which crops up here, and which I wish to point out, and that is the presence of dykes of basic rocks and of others of an intermediate character. If all the radiating fissures without exception had been filled up by acidic rocks, this would go far to prove the existence of such an upper acidic incandescent magma; in which case we should be forced to the conclusion that the chimney of the volcano reached lower down to the lower or basic layer. But it is difficult to understand how all the radiating fissures over an area of 12 miles in diameter could pass through the solid crust of the earth and through the fluid acidic magma, and how the lower basic rocks could be injected into them from below without disturbing the acidic magma, which certainly should have been forced up before. This difficulty might, however, be met by the suggestion that the radiating fissures in this instance did not reach so far down as the fluid acidic magma, and that the material for the formation of the dykes had been furnished from the crater itself, but it is scarcely conceivable that for a distance of six miles and for an altitude of several thousand feet the molten matter would have been forced in all directions from the central axis of eruption along these fissures, often only a few feet wide. Mr. R. Mallet,*

* Transactions of the Royal Society. Phil. Trans. 1873.

has proposed another theory, namely, that the principal cause of vulcanicity is to be sought in the compressing and crushing action taking place beneath the crust of the earth, and by which such a great amount of heat is generated that a fusion of rocks, often on a large scale, is easily produced. This theory would so far explain very well the difference in the composition of the rocks varying according to the depth where the crushing action was actually taking place; thus, if the same action were to act upon granites, trachytes, and other acidic rocks, the result would be the production of trachytes, whilst if basic rocks were fused, basalts would ascend towards or to the surface. Here, however, another great difficulty presents itself in the fact that, although the number of volcanic eruptions during which the caldera walls were built up must have been very great, no trachytic lava streams, with one single exception, have made their appearance, the whole series being of a basic, whilst most of the principal dykes are of an acidic nature. In such a case, the crushing of acidic rocks would have exclusively taken place when the dykes were being formed, and never when lava-streams issued from the crater's mouth, which is altogether improbable.

Although I have carefully read every work accessible to me in English, German, French, and Italian, treating on vulcanicity, I have not been able to find either any account of the existence of dykes in other volcanic regions converging so regularly to a few centres close to each other, or continuing over such a large area (always keeping the general direction with which they set out), as do those of the Lyttelton caldera; or again, offering an explanation for the difference in the composition of the dyke rocks when compared with the lava-streams or agglomeratic beds through which they pass. Mr. R. Mallet's excellent paper on the "Mechanism of Production of Volcanic Dykes,"* and of those of Mount Somma, in which an exhaustive account of the physical features of the dykes in the old caldera wall of Mount Vesuvius is given, unfortunately does not contain any physical theory to account for the mode by which fissures are produced, forming, when filled, volcanic dykes. If we take the heterogeneous nature of the material of which the caldera wall has been built up into account, it is astonishing that the dykes show such a remarkable regularity, always starting from a few points not far from each other, from which they radiate in all directions. It is still more remarkable to observe that all dykes which are cut by the Christchurch and Lyttelton railway tunnel have such a constant direction that they all, with one or two exceptions, appear to converge to one single axis behind Quail Island, a fact worthy of note if we consider the distance, which is more than four miles, measured to the most distant dyke in that tunnel. The only dyke with which I am acquainted,

* Quarterly Journal of the Geological Society of London, No. 128, Nov., 1876.

showing some remarkable irregularity, is the one in which the so-called Ellis Quarry is situated. This dyke, which strikes nearly east and west, goes out about 400 feet below the summit, where a saddle intersects the spur. Shortly above its lower termination it sends off a smaller branch in a south-west direction, also ceasing after a short course. Whilst the main dyke does not appear any more above the surface, the smaller south-western branch crops up again on the other side of the depression, now gradually changing its direction, so that, in its lower course, about 300 feet above the plains, it crosses the spur in a south-east and north-west direction. The whole system of dykes in the Lyttelton caldera wall is thus very different from the dykes of Mount Somma, of which, in his paper, Mr. R. Mallet gives us such a lucid and suggestive account, and of which many are fractured, displaced, and crushed, and have at the same time a wedge-shaped form. We can, therefore, assume that the fissures and dykes in the Lyttelton caldera were only formed after the latter had been so thoroughly consolidated that, after the formation of the fissures and their filling up by the principal dykes, no more changes of any importance took place in them; and that, moreover, the forces by which the walls of the volcano were starred from top to bottom, must have been far deeper-seated and more effective than the agencies by which Mount Somma was rent.

In conclusion, I wish to lay before you a few notes on the geological features of the Lyttelton and Christchurch railway tunnel, of which I made a careful survey during a number of years, as the work of the miner advanced. I watched this interesting and instructive work with great attention, this being the first time that a caldera wall of a large extinct volcano was to be pierced through. I prepared at the time a section on a scale of 1in. to 20ft., which I have great pleasure in laying before you.

The direction of the tunnel is N. 14° W. The first trial shaft was commenced in January, 1860, and the permanent works under contract with Messrs. Holmes and Co., began in July, 1861. The tunnel was laid out, and its execution solely superintended by Mr. Edward Dobson, C.E., Provincial Engineer. It was brought to a successful termination on May 25, 1866, when both adits met near the centre. The opening for railway traffic took place on December 9, 1867. The total length of the tunnel is 8,598 feet, and if we deduct from this 365 feet on the northern or outer side, and 105 feet on the southern or inner side, formed by slope deposits and loess, there remains 8,128 feet of rock of volcanic origin, of which the caldera wall has been built up. Classifying the rocks according to their lithological character, we find that the crater above the present waterline consists of—

61 lava-streams, having the character of a stony compact or porphyritic basalt.

54 lava-streams formed of a scoriaceous basaltic and doleritic lava, some of them changing so gradually into agglomeratic beds that the line between them cannot be clearly defined.

39 beds of agglomerates, a few of them changing into scoriaceous lava, but most of them consisting of scoriæ, lapilli, and other ejecta, imbedded in ashes. A few of them have a brecciated appearance.

19 beds of laterite, clays, and slope deposits, partly or wholly burnt by overlying lava-streams, and

1 small layer of bolus—together 174.

These beds are intersected by 32 dykes, 18 consisting of trachyte lava (of which five do not reach to the roof of the tunnel), and 14 of a basic nature (five of them being intermediate in character, trachy-dolerites). One of them comes from the top of the tunnel.

Beginning at the southern or Lyttelton side of the tunnel, we observe that a large bed of loam has been deposited upon the volcanic rocks, being thickest on the lowest third of the caldera wall. This peculiar rock, which, when in small pieces, is easily pulverized between the fingers, has a remarkable consistency and solidity when in large masses, and is of subaerial origin. It may be designated as loess, an expression now extensively used in Europe for similar deposits. It owes its origin to various processes, of which rain, wind, and vegetation are the principal factors. This bed of loess, which in some localities is more than 100 feet thick, changes gradually before we reach the volcanic rock to a true slope deposit, consisting of fragments of rock more or less rounded, the lines of junction being often impossible to trace, owing to the decomposition of the volcanic rocks immediately below the slope deposits. The greatest amount of agglomerate, consisting of scoriæ, lapilli, and ashes is, as might be expected, congregated on the inner side of the caldera wall, not far from the focus of eruption. These more or less incoherent beds, of which each was probably formed during one eruption, have generally an inward as well as an outward dip, of which the beds 232 to 241 close to the entrance of the tunnel at Lyttelton form a notable instance. They were without doubt deposited on the lip of the crater. Near the Lyttelton end they are much disturbed. Two stony lava-streams cross these agglomerate beds, and we have to assume that after No. 231 was formed, the lava-stream 233, ascending from the mouth of the crater, had consolidated over it, being in its turn covered by a new talus of ejecta sloping inwards to the crater's mouth. After these latter beds 234 and 234A were formed, a new stony lava-stream, No. 237, ascended, in which case Nos. 231, 234, and 238 to 241 were three distinct agglomerate beds, covered and preserved on their

inner slope by stony lava-streams, consolidated during their ascent. Or, to offer another explanation, we might regard these two stony lava-streams, 233 and 237, as having broken through the huge accumulations of ejecta which were heaped up all round the crater's mouth—a phenomenon frequently observed during violent volcanic eruptions, when a huge cinder cone is formed in a short time. A similar occurrence seems to have taken place more towards the centre of the tunnel, about 60 chains from the Lyttelton side, where a large stony lava-stream, No. 167, is seen to ascend through the agglomerate bed or beds, Nos. 166 to 168. The lava-stream, 163, in close proximity, might be considered to be the continuation of the former, which here flows down the steep side of the cinder cone. Gradually, as we retreat from the focus of eruption, the agglomerate beds decrease in number and size, but they still are occasionally present even close to the mouth of the tunnel near to the Heathcote entrance. Some of them consist in their lower portion of fine ashes, or lava d'aqua, and above of scoriæ and lapilli, so as to suggest that first fine ashes had been thrown out or had been brought down the side in the form of a mud stream, on the top of which large ejecta were afterwards deposited. Another agglomerate bed having an anticlinal or saddle arrangement is 22a, 17 to 20 chains from the Lyttelton end; it was evidently deposited on the rim of the crater, of which the uneven surface is well visible in its lower portion. After its formation, two more agglomerate beds were deposited over it, 216 and 227, and 211 and 228 in the section, each being separated from the other by a bed of laterite. Moreover, it is clear that, whatever may have been its origin, the lowest portion of this and several other agglomerate beds must have been deposited when in a state of high temperature, as the argillaceous bed below it has been burnt red, so as to take all the characteristics of a laterite. All round Banks Peninsula agglomerate and ash beds are visible in the cliffs, but they are like the lava-streams of small vertical extent only, and we have to approach more towards the centre of eruption when we wish to see them in their greatest dimensions.

The largest and most numerous stony lava-streams are met with towards the centre of the tunnel, where the basalt of which they are composed possesses the greatest hardness and crystalline texture. More towards the boundaries of the volcanic system, the lava-streams are much thinner and at the same time more porphyritic, amygdaloidal or scoriaceous, and it is very instructive to follow some of the lava-streams which form clear sections in the deep valleys radiating round the peninsula, from the summit of the caldera wall to their termination at its foot, and to note the gradual change in their size, and in the texture of the rocks of which they are composed. I have already alluded to the lava-stream 237, nine chains from the Lyttelton

end, but in connection with it I may here mention that the first shaft sunk by Messrs. Smith and Knight, the English contractors, unfortunately reached it soon below the surface of the ground, and continued all the way through it to the roof of the tunnel. This was one of the principal causes that the firm, being unacquainted with the formation of the crater wall, abandoned the contract so soon. The first stony lava in the tunnel, flowing down the slopes of the crater wall, is a small stream, No. 214, about 22 chains from the Lyttelton end. Several others of similar dimensions follow, till we reach stream 206, which might be the continuation of No. 237, 11½ chains from the Lyttelton end. This stream throws a great deal of light by its configuration on the manner of the flow of liquid lava. After flowing down the slopes, we see it shortly afterwards ascend again (No. 202) over a bed of agglomerate, and, after having reached the apex of the latter, descend again (No. 200), diminishing rapidly in size, the rock now becoming highly porphyritic and lighter in colour. The largest stony lava-stream of the whole series begins about 41 chains from the Lyttelton end, and continues without interruption to 52½ chains. Consequently, taking its angle of dip into account, it is more than 500 feet thick. More or less porphyritic on both sides, the whole central portion consists of a very hard basaltic rock, ringing to the hammer, irregularly jointed, with here and there a tendency towards spheroidal structure. This huge stream gains an additional interest from the existence of three caves in its centre, which, however, have partly been filled up with thin plates of basalt of the same texture as the lava-stream, and which lie more or less horizontal. They are coated over and often cemented together by sphærosiderite. Sometimes they lie in such regular order, and so loosely upon each other, as if they had been artificially placed in that position. The open space, or cave proper, is always on the southern side of each cavity. The only explanation I can offer as to their formation is that gases have been enclosed in this portion of the lava stream, which in course of time were absorbed, and that liquid matter from the upper portion of the stream found access to the cavities, gradually filling them up, but that the channels of communication were stopped before the whole of the gases still remaining in the southern parts of each had been absorbed.

Another stream of large dimensions is No. 14, beginning 20 chains from the Heathcote end. It is over 100 feet thick, has a jointed structure, the central portion being spheroidal, with concentric layers. All the stony streams in the tunnel above the latter are very thin, but it is possible that the scoriaceous basaltic lava (the violet beds of the section) which overlie them, are only their upper portion, the bottom of the streams, owing to their thinness and to the distance from the centre of eruption, not having

been able to cool to the stony compact form. I may, however, observe that the boundary line between both kinds of rock is, in many instances, very distinct and clearly defined. These scoriaceous beds occur throughout the tunnel; they are sometimes of considerable dimensions, some of them being over 100 feet thick. In speaking of the formation of the Lyttelton caldera, I have already pointed out that it has been built up by volcanic rocks belonging to two distinct divisions, of which the basic rocks have furnished all the material for the lava-streams, agglomeratic and tufaceous beds, whilst the principal portion of the dykes owe their origin to the acidic division. As might be anticipated, the dykes are most numerous near the focus of eruption; thus we find the greater portion of them near the Lyttelton side, several of them not reaching to the roof of the tunnel. Of these dykes, No. 29 is the most important. It consists of a soft flaky and lustrous trachyte, and possesses, like most of the other acidic dykes, the characteristic feature that it is accompanied on both sides by a selvage of tachylite, sometimes two or three inches thick. This change in the character of the bed rock is especially visible when the dykes pass through agglomeratic or tufaceous beds. It shows clearly that the volcanic matter ascending by these fissures was in such an intense state of fusion that it was able to alter the rocks on both sides so thoroughly for such a distance. In some instances the dyke rocks themselves have a selvage of tachylite, the bed rock being unaltered. It is worthy of notice that the basaltic dykes have not produced the same effect, the rocks on both sides being generally unaltered. Large beds of loess, similar to those deposited on the inner side of the caldera wall, have also been passed through on the Heathcote side. Of minerals of secondary origin found in the tunnel, the most diffuse is sphærosiderite, which usually coats the pores and cavities of scoriaceous lavas. Of others, calcareous spar and aragonite are the most conspicuous. The latter is younger than the former, having often been deposited on the surface of the calcareous spar coating the small geodes. In a few localities, hyalite fills small clefts, or is found in a stalactitic form.

I shall close this address by offering a few observations on some other physical features of the beds through which the tunnel has been excavated, and as I noted them on the large section during the survey. Forty chains from the Heathcote end, a scoriaceous lava-stream, fifteen feet thick, and accompanied on both sides by beds of laterite and agglomerate, was passed, which was so loose and full of water that the ground had at once to be heavily timbered. All the cavities in the lava are lined with sphærosiderite, on which crystals of calcareous spar have been deposited. At 40¾ chains on the same side, in a bed of laterite, four feet above the floor of the tunnel, a small spring was struck, drying up a few months after; 35¼ chains from

the Lyttelton end, the lava-streams, when first passed through, were so wet that the workmen could scarcely continue the work. In these streams all the cellular cavities were either lined with sphærosiderite or filled with calcite. Sixteen chains from the Lyttelton entrance, in the agglomerate bed No. 228, and from a fissure reaching from the roof of the tunnel, a copious spring flows which has a constant temperature of 65·20 degrees Fahrenheit, consequently 12·20 degrees above the mean temperature of Christchurch—about 53 degrees. Several eels have been caught near this spring in the drain which runs from here to the mouth of the tunnel. There being no connection with any other watercourse, these eels must have ascended by the spring; they belong to the species *Anguilla aucklandii*, Rich., and have properly developed eyes. During the construction of the tunnel it was frequently observed in the north, or Heathcote end, that the water rose in the floor before a south-west gale, and subsided before the gale lulled; no observations could be made to ascertain whether the state of the tide had anything to do with this. The height to which the water rose was somewhat under half an inch. After the earthquake of August 17, 1868, this spring in the tunnel increased to such an extent that it laid the rails slightly under water; after a few days it decreased again to its former volume.

Art. LXXXV.—*Notes on a Salt Spring near Hokianga.* By J. A. Pond.

[*Read before the Auckland Institute, 9th September, 1878.*]

In looking over the Transactions of the New Zealand Institute, just to hand, I read with pleasure the paper by W. Skey, on the Mineral Waters of New Zealand, in which he gives the analyses and description of waters from all known springs in the Colony. As we might expect, the North Island, and particularly this district, has supplied the large majority of samples; but though much has been done in this respect there are very many springs containing mineral salts, and having medicinal properties, which still remain unexamined, and leave a rich field for those having the will and capacity to bring them to light, or rather to the Transactions.

Some months ago, Judge Monro first mentioned the existence of a salt spring to me, and on a later occasion kindly placed a few ounces of the water at my disposal, too small an amount to make a complete analysis of, but as its especial characteristic was its saline nature, I have made a partial quantitative analysis, which I give below.

The spring in question is situated in dense bush, on the dividing range between the Wangape and Waihou rivers, the latter of which runs into Hokianga Harbour. The distance from the sea in a direct line is about nine or ten miles, and is at a considerable elevation above sea level; hence the presence in large quantity of chloride of sodium is highly interesting, showing, as it does, that there must be in the locality a deposit of salt, probably some distance below the surface, which I should judge from the fact of its not being more highly impregnated. As will be seen by the analysis, this water contains about the same percentage of chloride of sodium as ordinary sea water, but differs therefrom in the absence of sulphates. The following gives the chief constituents, so far as the small quantity of the sample at my disposal would permit:—

The solid matter equals 2937·558 grains per gallon, composed of—

Organic matter	51·115
Soluble silica	49·562
Carbonate of Magnesia	18·710
Chloride of Potassium	1·9
„ Sodium	2797·4
Lime and Iron	traces
Sulphuric Acid	„
Loss	18·871

The sample was accompanied by a very large amount of fine sedimentary deposit, which proved to be silicate of alumina, with a trace of iron and lime. After standing some days the water was opalescent, acid reaction and strong saline taste. From the appearance of the deposit, and a few fragments of gravel brought separately, I should judge the locality from whence the water was taken to be of a clay-slate formation; but during the coming summer I hope to make an examination of the place in which this spring is situated, and a further one of the water. Spectroscopically I could not detect lithia. As I have already mentioned, this spring ranks higher than any other in this Colony, so far as records show, in regard to the amount of alkaline chlorides present.

While speaking with respect to springs not included in Mr. Skey's report, I will add some information respecting two other mineral waters from our district which have been analyzed. The first is located near Whangarei, and is highly charged with carbonic acid gas. The springs are surrounded with a vitreous-looking silica, and in places with large quantities of a very light porous rock, presumed by the residents at first to be meerschaum, but this I find on examination to be incorrect, the chemical tests showing it to be a silicate of alumina, and the microscope resolving it into an infusorial earth, well worthy the consideration of our

microscopists. Mr. Cheeseman, to whom I am indebted for the samples just alluded to, forwarded some of the water to Mr. Skey, of Wellington, whose report, just received, I will now read.

The other sample I have now to mention is a hot spring at Motuhora (Whale Island), in the Bay of Plenty. Here the water flows out of a valley in large quantities into the sea, the heat being so great as to cause volumes of steam to rise as the water flows over the sand. The temperature of this spring, where it rises from the ground, is 198° Fahr., the taste being extremely acid, and the water very clear. I am indebted to Mr. Tunny for the analysis, which is as follows:—

Sulphate of Soda	17·60	grains per gallon.
„ Lime	7·52	„ „
„ Magnesia	5·00	„ „
„ Alumina	48·48	„ „
„ Iron	9·38	„ „
Sulphuric Acid, free	138·32	„ „
Silica..	24·00	„ „
	250·30	

Art. LXXXVI.—*Notes of a Traditional Change in the Coast line at Manukau Heads.* By S. Percy Smith.

[*Read before the Auckland Institute, 18th November, 1878.*]

Some thirteen years ago, when encamped one night with a party of natives on the long beach which extends from Manukau to Waikato Heads, the conversation over the camp fire turned upon some old tribal boundaries, one of which ended at a place said by Aihepene Raihau, the narrator (who was then living at Waiuku, but who now, having married the Princess Sophia, resides in the King's country), to be now covered by the sea. Upon enquiring further of him as to this particular place, he informed me that many generations ago the coast-line extended much further seaward than it does at present, projecting in a curved line from Manukau Heads to the Waikato River. This point he described as a low, sandy country, with numerous sand-dunes, fresh-water lakes, with clumps of tall manuka trees scattered over its surface.

The lakes were much resorted to by the natives in those days, on account of the great number of eels found in them.

He further stated that it was a three days' journey at that time for a man following the beach from Manukau to Waikato Heads, whereas the present coast-line is a very nearly straight line, and the distance may be

walked by an ordinary pedestrian easily in one day, being only about twenty-five miles.

Aihepene also told me that the Manukau bar, even within the memory of those living, was dry land; and that he himself, when a boy, had accompanied his parents to the bank on which H.M.S. "Orpheus" was wrecked, for the purpose of fishing and collecting birds' eggs. The natives did not, as I understood him, live upon these banks, but used to make periodical visits to them in their canoes, for a few days at a time for fishing purposes, living in houses which they had constructed there.

I much regret that I did not at the time make further enquiries of the old natives living at Waiuku and its neighbourhood, with a view of getting corroborative evidence of these changes. With respect to that part of the story, however, which relates to Manukau bar, I think there could be no mistake, as my informant said he had himself visited the place, and I can conceive of no possible reason for his imposing on me, especially as the information was volunteered. That such changes do take place in the coast-lines of various countries, without the aid of submergence or elevation, is well known, as, for instance, on the east coast of England, where, within the historical period, vast changes have taken place; villages, the names only of which are now preserved in old records, have entirely disappeared—swallowed up by the ever-encroaching waves.

As for any evidence remaining of such a low, sandy country having once existed, I think we could scarcely expect much. The Admiralty chart of that part of the coast is very bare of soundings, and those given do not differ much from soundings at the same distance from the shore for many miles both north and south, until the great "bottomless pit" is reached, north of Kaipara Heads. The present coast is an almost continuous line of steep cliffs, with, at their bases, in some few places, a small strip of sandy flats, generally covered with high manuka; but even these are fast disappearing, as I learn from a settler resident in that locality. These cliffs are covered on top by a range of sand-dunes, which extend uninterruptedly from Manukau to Waikato, and are the source from whence is derived the strip of fertile land lying immediately to the east of them. The origin of these sand-hills, occurring as they do on top of perpendicular cliffs, is often obscure, for we cannot suppose the sand to have been blown perpendicularly upwards from the beach, in direct opposition to gravity, although in the few gaps or gullies breaking through the cliffs down to the beach, the sand undoubtedly gradually is forced upwards by the strong westerly winds, and then accumulates in dunes on top. But on the supposition of the existence of the submerged country as described, occupying a position at the foot of an older coast-line now represented by the present cliffs, a probable origin is suggested, thus:—

In a low sandy country exposed to the full force of the westerly winds, the light materials would continually be driven easterly until brought up by the cliffs, against which they would be piled until a sufficient slope was formed to allow of their finally mounting the top, and then forming the sand-dunes we now see. Those who are acquainted with the strip of country lying on the South Kaipara head, and extending thence to Muriwai, will at once recognize that the above supposition is applicable as a description of that part of the country. Here the cliffs are present at from one to three miles from the beach, but generally hidden by a sloping bank of sand, partially covered with vegetation, with a line of sand-dunes forming the highest parts of the range. Even the traditional lagoons, forming a long interrupted line of fresh water, and celebrated for their eels, are also there, completing the similarity between this country and that described by Aihepene. The north head of Kaipara furnishes perhaps a better illustration than even the south head, for here we have in close conjunction the low sandy tract with its moving sand-dunes, lagoons, and scattered thickets of manuka, with the inland line of hills, covered by sand; and to the north, a few miles, the same line of hills rising perpendicularly from the beach with the long and broken range of sand-hills capping the cliffs.

The natives of Kaipara have a tradition that the banks at the bar of that harbour were once dry land upon which their forefathers lived and cultivated; but this must have been at a much earlier age than that in which part of the Manukau Bar was dry, for here we find that this tradition is mixed up with one of their old myths, inasmuch as this is given as the locality in which Tinirau's pet whale, Tutunui, was killed by Kae as related in Sir George Grey's "Mythology and Traditions of the New Zealanders."

We need not seek far for sufficient causes for these alterations in the coast-line. The known alternations in the level of the sea-line, caused by elevation or depression of the land giving rise to and altering the directions of currents, is ample to account for the disappearance of such a strip of land as is described in Aihepene Raihau's tradition as above.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting. *13th July*, 1878.

A. K. Newman, M.B., Vice-president, in the chair.

New Members.—D. Climie, C. E. Macklin, T. W. Kirk, T. King, E. P. Field, Herbert Rawson.

Attention was called to several additions to the Museum and library, which were placed on the table for the inspection of members.

1. "On some of the Terms used in Political Economy," by John Carruthers, M. Inst. C.E. (*Transactions*, p. 3.)

Mr. Maxwell said that as regards Mill's definition of wealth, that "it is anything useful or agreeable which possesses exchangeable value," he concurred with Mr. Carruthers that the word "exchange" should be omitted, because if we regard the community in the world as a whole, since there is no one without the world with whom this community can exchange its possessions, it would follow from Mill's definition that the community as a whole possesses no wealth, and this is manifestly absurd. Regarding the divisions proposed by Mr. Carruthers of wealth into direct wealth and implements, he did not think a distinct line of demarcation can be drawn. It is impossible to define the point at which bread, for instance, may be described as useful for its own sake, although bread is stated to be an article which is direct wealth; the whole of the combinations of circumstances and things which go to produce bread, from the plough to the process of digestion, are so involved that it seems almost impossible to state at what particular period the bread is useful or not useful for its own sake. A chair may be direct wealth while occupied for rest, while if its use be made subservient to the purpose of listening it becomes an implement.

Mr. Martin Chapman considered that the controversy was principally owing to the ambiguity of our common language. Few people know how ambiguous our ordinary language is. Lawyers know it, and are always trying to guard against it, with very indifferent success. That this does not cause trouble is principally owing to the fact that we usually converse with persons whose minds have been trained in a manner somewhat similar to our own. When this is not the case trouble ensues, as, for instance, when a soldier and a sailor converse they soon think each other fools, because one talks pipeclay, the other pitch. The present difference may be due to a similar reason, viz., that the critic and the criticized do not look at the matter from the same standpoint. This indefiniteness appeared in the paper; it did not appear at all clearly what Mr. Carruthers meant by a "man;" was it the individual, the family, community, or all mankind, because to each of these a different test would have to be applied? The stone which a lunatic thinks will transmute gold cannot be called wealth; but the possession gives him comfort. So the torpedoes used by a conquering nation to enslave its neighbours increase the happiness of one nation, but probably not of the whole world; yet they would be

probably called wealth by most. Again, it did not clearly appear in what sense Mr. Carruthers used the words "wealth of the world" as different from simply wealth. Mr. Carruthers spoke also of "capital" and "capital of the country." Mr. Chapman wished to know the difference between capital of the country and wealth of the country.

Mr. Carruthers, in reply, said it was not necessary to go into metaphysical nicety in definitions of political economy; that it certainly was impossible, as remarked by Mr. Maxwell, to strictly define the boundary between implements and wealth which is useful for its own sake. Bread might be said to be an implement for satisfying hunger, and the satisfaction of hunger an implement for procuring happiness. But the division which he had suggested of wealth was useful, and quite accurate enough for the purposes of the science. He said, in reply to Mr. Chapman, that by man he meant any one man, and that the stone which pleased a lunatic was wealth as fully as the diamond which pleased people who were not lunatics. A torpedo was wealth, because it was useful to the user; he did not recognize any algebraical minus sign which would make the discomfort which the torpedo caused to the person against whom it was used neutralize the advantage which it gave to the user; The wealth of the world meant the sum total of useful things at any time in existence. He said he did not use the word capital as meaning wealth at all; he considered it a word which should be altogether given up by the political economist, as being too likely to suggest meanings different from the definition.

The Chairman proposed a vote of thanks to Mr. Carruthers, not only for his present paper, but for the great assistance he had always rendered to the society. He regretted that the society should lose such a valuable member, and he had hoped to see Mr. Carruthers one day president, as he had no doubt he would have been had he remained in Wellington.

The vote of thanks was carried by acclamation, and Mr. Carruthers briefly returned thanks for the good wishes of the society towards him.

Second Meeting. *3rd August*, 1878.

T. Kirk, F.L.S., President, in the chair.

New Members.—Rev. Father Sauzeau of Blenheim, A. P. Stuart, J. G. Fox.

In opening the proceedings, the President remarked that the Society had entered upon the second decade of its existence as a society affiliated to the New Zealand Institute. Looking back to the close of the first volume of Transactions, he found that the number of members had increased from 102 to 225, and that the total of affiliated societies had increased from four to seven, numbering considerably over 1,100 members, a fact which was exceedingly gratifying, as showing that the taste for scientific pursuits was widely diffused through the colony. The ten volumes of Transactions had been contributed by about 200 workers, and contained a vast amount of information of great value on the zoology, botany, and geology of the country, but not in a shape fully available for the general public. It was therefore advisable that a united effort should be made by the various societies to provide funds for the publication of a Fauna of New Zealand as complete as the present state of our knowledge would allow. He referred to the recently published parts of Mr. Buchanan's work on the indigenous grasses of New Zealand as a step in this direction, and characterized the plates as creditable alike to the author, the Geological Survey Department, and the colony, and expressed his regret that the plan of the work had not been so extended as to admit of its being brought fully abreast of the botanical knowledge of the day.

1. "How New Zealand may continue to grow Wheat and other Cereals," by J. C. Crawford, F.G.S. (*Transactions*, p. 149.)

Mr. Kirk considered the remarks in the paper regarding the sterile nature of the Auckland soil required modification. He had seen very fair crops grown in that locality with little or no manure.

Dr. Hector agreed with the author that a good deal of potash was taken out of the colony in the grease of wool, and he knew that this potash grease is saved in England, and used in the after manufacture of wool. With regard to the Auckland soil, he considered it was inferior in some places chiefly owing to the want of drainage or breaking up, Soluble silica is the constituent most essential, and therefore a clay soil is, on the whole, the best, as it retains manure longer. Altogether he thought Mr. Crawford's remarks were valuable.

Dr. Newman considered that possibly a time would come when it would be difficult to procure sufficient food of the ordinary kind, and the wisest plan would be to manufacture the various constituents mentioned directly into food for consumption. He did not see why they could not be as easily manufactured into food themselves as used to assist in producing food from other sources.

Mr. Young thought with Mr. Crawford that much could be done with the assistance of chemistry in keeping up the quality of the soil. The most economical and best agent to employ would be phosphatic guano, which he thought could be procured in large quantities from numerous islands.

Dr. Buller pointed out that, in the neighbourhood of the hot springs, there was a quantity of nice, soft mud, sometimes eaten by the natives, which might serve the purpose indicated by Dr. Newman.

Mr. Kirk said that the sulphur works at Auckland would supply sulphuric acid, which would be most useful for our soils. He stated that nitrogen only formed a very small proportion of the dried plant, frequently less than 1 per cent., and rarely so much as 3 per cent., and therefore could be more easily supplied.

2. "Additions to List of Species, and Notices of rare Occurrences, since the publication of 'The Birds of New Zealand,'" by Walter L. Buller C.M.G., Sc.D. (*Transactions*, p. 361.)

3. "Remarks on the Long-tailed Cuckoo *(Eudynamis taitensis)*," by Walter L. Buller. (*Transactions*, p. 353.)

4. "On the specific Value of *Prion banksii*," by Walter L. Buller. (*Transactions*, p. 351.)

5. "Further Notes on the Habits of the Tuatara Lizard," by Walter L. Buller. (*Transactions*, p. 349.)

Dr. Hector considered Dr. Buller's papers were most interesting, and no doubt some new species would yet be added to the birds of New Zealand—instancing a red wattle-bird in the western forest, of which he had information. With regard to the tuatara, he agreed with Dr. Buller that the two species—*Sphenodon punctatum* and *S. guntheri*—would hold good. As regards their feeding habits, he found that they would eat almost anything that moved.

The President considered that the difference in disposition might be accounted for by difference in age, and no doubt the temperature had some influence on their habits.

Dr. Newman remarked that few reptiles cared to devour any object that was stationary, they require to see it move. He did not agree in thinking that so slight a difference as indicated by Dr. Buller in regard to the birds mentioned could make a distinct species.

Dr. Buller, in reply, pointed out that the great test as regards species was to ascertain whether the differences were constant. As naturalists understood the term he considered his examples were distinct species.

6. "Notes on the Breeding Habits of the Katipo *(Latrodectus katipo)*," by C. H. Robson. (*Transactions*, p. 391.)

Dr. Buller called attention to his paper, in Vol. III. of the Transactions, on this spider, which gave a good deal of information regarding its habits. A professor in Sweden had since pointed out that the Katipo was the representative of an entirely new genus; and Dr. Smith, a celebrated homœopathist, considered the extract from the spider in question would produce a most valuable drug in homœopathy. He had requested him (Dr. Buller) to forward a quantity to England for experiment.

The President said that it was strange that this was the only poisonous animal in New Zealand, and also that only two plants were known to be poisonous.

Third Meeting. 17*th August*, 1878.

T. Kirk, F.L.S., President, in the chair.

New Member.—W. G. Rutherfurd.

1. "On the Deflection of Shingle-bearing Currents and Protection of River Banks by Douslin's Floating Log Dams," by H. P. Macklin. (*Transactions*, p. 144.)

Mr. Maxwell said that this plan had been successfully carried out in many places He did not think there was anything new to engineering in the paper.

Dr. Hector explained that the author did not give this as a new invention, but merely wished to point out how successfully the plan had worked as applied to the Opawa River, in protecting the town of Blenheim.

2. "Remarks on a Species of *Lestris* inhabiting our Seas," by Walter L. Buller, C.M.G., Sc.D., etc. (*Transactions*, p. 355.)

The author exhibited specimens in illustration.

Dr. Hector pointed out the difficulty of obtaining many of the oceanic birds, naturalists having to depend on stray specimens cast ashore by the waves or blown inland by a storm, and he expressed a hope that members of the society would never lose an opportunity of securing such specimens and forwarding them to the Museum for critical examination. He mentioned another larger species of *Lestris* known as the sea-hen, of which he obtained some examples in Otago soon after he came to the colony.

The President said that Dr. Buller's paper would form a valuable contribution to the Transactions. The sealing parties visiting the various islands might be arranged with to collect such specimens.

3. "Further Observations upon certain Grasses and Fodder Plants," by S. M. Curl, M.D. (*Transactions*, p. 403.)

The President remarked that persons engaged in testing the properties of plants adapted for feeding stock in this colony were engaged in work beneficial to the whole community, and therefore he welcomed the paper now contributed by Dr. Curl. At the time he observed with regret that no mention was made of the condition under which Dr. Curl's experiments were performed, such as quality of soil, time requisite for the maturation of the plant, mode in which fed off, and other elements necessary in order to form a correct opinion of the value of each kind. Not more than two or three of the species mentioned in the paper were adapted for mixed pasturage, although most would doubtless be found of value as fodder. He remarked that *Agrostis solandri*, recommended by Dr. Curl, was a collective species, chiefly consisting of two New Zealand grasses, *Agrostis æmula* and *A. billardieri*. *Poa aquatica* was merely a synonym for *Glyceria aquatica*, although the two are given by the author as distinct plants. *Glyceria fluitans* was a grass of undoubted value, as was proved by the condition of horses and cattle feeding upon it, wherever naturalized in the colony. Referring to Dr. Curl's use of the term "acclimatized," he stated that a fallacy was involved in the popular acceptation of the term, as there was no evidence to show that plants or animals possessed the power of gradual adaptation to peculiarities of climate or soil other than those for which they were originally fitted. This was generally recognized by scientific men, who used the term naturalized instead of acclimatized.

4. "Preliminary Note on the Presence of one or more Hydro-carbons of the Benzol Series in the American Petroleum, also in our Petroleums," by W. Skey. (*Transactions*, p. 469.)

5. "On a Property possessed by Essential Oils of whitening the Precipitate produced by mixing a Solution of Mercuro-iodide with one of Mercuric-chloride," by W. Skey. (*Transactions*, p. 470.)

6. "Preliminary Note on the Production of one or more Alkaloids from Fixed Oils, by the Aniline Process," by W. Skey. (*Transactions*, p. 471.)

7. "On the Production of Platino-iodides of the Alkaloids," by W. Skey.

8. "On a further Occurrence of the Australian Tree Swallow (*Hylochelidon nigricans*) in New Zealand," by Walter L. Buller, C.M.G., D. Sc. (*Transactions*, p. 360.)

The author remarked on the extraordinary fact of such a bird performing a journey on the wing of upwards of a thousand miles without a break or rest.

Dr. Hector wished to be informed whether this bird was gregarious in its native country, and whether it had come over singly or in flocks?

Mr. Martin Chapman gave some interesting particulars of the breeding habits of the tree swallow, as observed by him in Australia, where it is not gregarious like the sparrow. He advocated its introduction and naturalization in this country.

Dr. Buller stated that a flight of these swallows had been seen at Wakapuaka, near Nelson, in 1856, when specimens were obtained by Mr. Lee, one of which is now in the Otago Museum.

The President said that he believed the bird was of more frequent occurrence in New Zealand than was commonly supposed, and he mentioned the circumstance of a pair being shot at Auckland some time ago. With regard to the proposed introduction of this

swallow, he doubted very much whether, if brought here, it could be induced to remain with us, the migratory instinct being very powerful.

9. Dr. Hector exhibited a telephone and two forms of the microphone, made by Mr. John Kebbell, and explained the principles of their construction. The microphones were placed on the lecture table, and connected by wire laid to different parts of the Museum with several telephones in circuit; the marvellous transmission of faint sounds was readily illustrated. The experiments performed were to some extent marred by the extreme sensitiveness of the instruments, as the irregular noises produced by the rustling movements of the audience frequently overpowered the sounds that were intended to be transmitted. The sounds of the voice, of tuning forks, and slight friction of the sounding boards of the microphones were, however, rendered distinctly audible throughout the complete circuit.

A cordial vote of thanks was passed to Mr. Kebbell for his kindness in exhibiting to the Society these interesting inventions.

Fourth Meeting. 31*st August*, 1878.

T. Kirk, F.L.S., President, in the chair.

New Members.—G. Morton, J. R. W. Cook, William Berry.

Additions to the library were laid on the table, and Dr. Hector drew attention to the following fishes lately added to the Museum collection, viz., *Holocanthus arcuatus*, *Monocanthus hippocrepis*, and *Serranus trutta* (the latter being a new species) from Fiji, collected and presented by Lord Hervey Phipps; also, *Ceratodus forsteri*, from Queensland, presented by Sir C. Wyville Thompson.

1. "On some of the Causes which operate in Shingle-bearing Rivers in the Determination of their Courses and in the Formation of Plains," by J. P. Maxwell, A.I.C.E.

ABSTRACT.

The author contended that the Canterbury Plains were formed by the action of the rivers in conveying shingle from the ranges and depositing it in their lower courses and at their mouths; that continual changes in the courses of the streams were effected by these deposits, thus giving rise to the distribution of material over extended areas; that this process was still going on, and that the elevation and extension of the plains would proceed while the supply of detritus from the ranges continued; that the features were largely modified by the action of the sea in distributing the shingle along the coast-line; that examination of the river beds showed that they are sometimes elevated along the middle lines of their length, and that streams flowed on either side, cutting notch-like channels in the older plain formation; that the evidence of these channels on both sides of the river beds is a sufficient refutation of the theory of the supposed effect of the influence of the earth's rotation in causing erosion on one side only.

Dr. Hector said he agreed with the views of the author as far as they went, but he thought that the formation of the great fan-like deposits of shingle that go to make up

the surface at least of the Canterbury plains was not so simple a process as stated. As stated, it might suit the conditions of a small deposit, but these fans were twenty to thirty miles in diameter, and could only have been built up by successive changes in the courses of rivers as they gradually raised their beds and then broke away from them. The resulting fan was made up of many river beds, radiating from one point or gorge. A most important feature not mentioned by the author was the formation of secondary fans in front of those earlier ones formed by the gradual erosion and deepening of the notch or gorge in the rocky bed through which the river was finally liberated from the mountains. As this notch was lowered the river became confined to a deep terraced valley excavated in the shingle of the earlier fans, the shingle removed going to raise the bed in a lower part of its course. This, in his opinion, gave rise to the apparent concave surface of the plains in the author's section.

Mr. Travers pointed out that the essential point in the fan-like arrangement of detritus was the diminished velocity of the river after escaping from the upper part of its course whence the detritus was derived. He described the prodigious effects of the great flood of 1867 on the valley deposits of the Wairau River, high level terraces of gravel having been completely swept away by lateral tributaries, leaving shelves of bare rock, while the rocky and previously impassable bed of the main river was converted into a smooth surface or plain for miles. That was the effect of one short flood, and he thought that it was evidence that no flood of similar magnitude had occurred since the terrace skirting the valley had been formed.

Dr. Hector stated that the amount of detritus carried out to sea on that occasion had added ten chains width to the beach for miles along the coast, so that the fences running out on the shore had to be lengthened.

Mr. Maxwell, in reply, considered the remarks made did not conflict with the views expressed in this paper, but only extended their application. His object was to refute the idea that the changes in the direction of such rivers could be controlled by the rotation of the earth, as suggested by Dr. Haast and Mr. Baines in the last volume of "Transactions."

2. "Some Notes on the D'Urville Island Copper Mine," by S. H. Cox, F.C.S., F.G.S., Assistant Geologist.

ABSTRACT.

The mine is situated at the southern end of D'Urville Island, the copper occurring in a belt of serpentine, which may be traced from the Dun Mountain, at Nelson, to the Croixelles, and again throughout the length of D'Urville Island. This belt of serpentine is in contact with certain coarse-grained green sandstones and banded slates of the Maitai series, in which veins of quartz with nests of pyrites occur, the strike of the slates being about N.N.E.

Outcrops of cuprite, coated with malachite and azurite, have been traced at intervals over a distance of 900 yards, or thereabouts, in a N.E. and S.W. direction, these outcrops generally occurring on a bare ridge of serpentine, which is about the centre line of the piece of ground which has been leased from the Maoris for mining operations, and four small shafts have been sunk to prove the ore at different points. These shafts do not

appear to be in the same band of ore, but on at least three different ones, and the author thinks it probable that there is yet another.

The surface prospecting has been attended with exceptionally good results, rich deposits of ore having being traced for a considerable distance; and on visiting the mine, the author could not but form a favourable opinion of the mineral wealth occurring on D'Urville Island. At the present time the prospects of the mine look most encouraging, and had it not been that a tunnel had been put in to intersect the ore-band, and had failed to cut it, one might have been led to form a most extravagant idea of the wealth which would accrue to the shareholders in the speculation; but this tunnel proves, what has frequently been demonstrated elsewhere, that ore deposits in serpentine are not as continuous and well-defined as the poorer lodes which occur in sedimentary deposits. This fact points to the necessity of keeping exploratory workings well ahead, and even closer attention will have to be paid to this class of work here than in ordinary metalliferous mines.

Dr. Hector remarked that Mr. Cox had not specified the value of the ore. When pure, cuprite contained about 89 per cent. of metallic copper, and copper glance about 79 per cent.; but the value of the ore raised at D'Urville Island at present was about £11 per ton. He pointed out that the serpentine belt could be traced at intervals from D'Urville Island to Nelson, and thence through the ranges to Jackson's Bay, where Mr. Macfarlane had noticed its occurrence, and from this point it split into two belts. He also referred to the occurrence of copper ore in the North Island, and said that the copper of Great Barrier Island was probably not in the same formation, but that the relations at this point are more obscured by newer formations than in the South.

Mr. Travers said that he unfortunately had considerable experience of the patchy character of ore deposits in serpentine, having been one of those who worked the Dun Mountain ore. His advice was to take all the copper which could easily be found, and not to sink any large amount of capital in trying to open up regular mines in such uncertain deposits, as the ore occurred merely in bunches, which were disconnected, and which appeared only to occur on the surface.

Mr. Waterhouse was glad to have the information conveyed in Mr. Cox's paper. He had some experience on the subject in South Australia, and quite agreed with Mr. Travers' remarks, and he would be surprised if the D'Urville Island copper mine paid in the long run. He did not consider that the fact of rich specimens of copper being obtained from the mine in any way guaranteed the success of the undertaking, for there were innumerable instances in South Australia where quite as rich specimens were obtained, but no inducements offered to open up mines with reasonable prospect of success, as where the ore was patchy, and the country hard, these deposits never turned out well. He stated that copper which would pay to work in England would not do so in the colonies, but that to prove a success here the following were necessary:—1st. The ore must be near the sea. 2nd. It must be in very large quantity. 3rd. It must be in soft country, where it could be worked with comparative ease. He pointed out that the only mines in South Australia which have paid have been those which have been started without any capital, instancing the Bulla Bulla and Moonta mines, &c., which yielded large quantities of ore from the very first, and were in soft ground, and stated that all the other mines which were in hard

ground did not pay. He referred to the South African mines, where large deposits of ore had been found recently, yielding as much as £60,000 worth of copper in six months. He advised caution in opening up the D'Urville Island mine, and said that only those who could afford to lose the money which they invested should take shares in this mine.

Mr. Kirk said that we were indebted to the speakers for very valuable remarks on this subject. He thought that the Great Barrier copper had been worked and abandoned, but that very probably there was yet much ore to be extracted from the mine.

Mr. Cox, in reply, said that the colonial mines were generally extravagantly worked, and that although, in Cornwall, ore yielding as little as 3 to 4 per cent. of copper could be worked, the miners there were content to make £3 per month, with the chance of a good month's pay now and then, in consequence of rich deposits being found, all the mining there being let to tributers; but that at D'Urville Island the miners were getting as much as £3 a week. Also, the ore in Cornwall is in well-defined lodes, whereas here it is in irregular deposits, and, as he had pointed out in his paper, it would be necessary to follow the ore very carefully, and ensure a considerable output before sinking capital in tramways to get the ore away, or smelting works to reduce it.

3. "On Additions to the Carcinological Fauna of New Zealand," by T. W. Kirk. (*Transactions* p. 392.)

Dr. Hector pointed out the value of such papers, and hoped the society would have many others from the author of equal interest.

4. "On the Cause of the Movements of Camphor when placed upon the Surface of Water," by W. Skey. (*Transactions*, p. 473.)

This paper was illustrated by experiments to show that the true cause for this movement is not that hitherto stated, but is due to the solution of the camphor and the formation of a hydrated oil, which is rapidly absorbed. The motion is due to the tendency of the particles of camphor to slide off the elevated surface of the pellicle of oil that forms on the surface of the water. It was shown that small fragments of cork or other light substance moistened with oil, either a fixed oil or an essential oil, or a drop of bisulphide of carbon, exhibit the same phenomena, and that it is therefore not due to the property which camphor possesses of giving off vapour in the solid state. The experiments exhibited by Dr. Hector to demonstrate this view were extremely interesting and beautiful.

Mr. Travers stated that he remembered to have observed the same phenomena when a drop of iodized collodion was accidentally dropped on the surface of water.

Dr. Hector said that Mr. Skey wished him to state with reference to his discovery mentioned at last meeting, that hydro-carbons exist in many fats and oils not hitherto supposed to contain them, and that they can be transformed into alkaloids by the aniline process; that in pursuing his investigation he had obtained an alkaloid from butter, thus completing the general statement that both animal and vegetable fats contain such hydro-carbons.

Fifth Meeting. *28th September*, 1878.

A. K. Newman, M.B., Vice-president, in the chair.

New Members.—Dominick Browne, Rev. Philip Walsh, of Waitara.

1. "Memorandum of the Keá," by the Hon. Dr. Menzies, M.L.C. (*Transactions*, p. 376.)

Mr. Travers said that the first report of this proclivity in the Keá was from the head of Lake Wanaka, but it was discredited. He had been aware of the fact himself, and it was now beyond a doubt. The kaka also fed on flesh, but never attacked the living animal.

Dr. Newman remarked that it was strange that these birds should prey upon such large animals, when it was considered that before the introduction of sheep they had not probably seen anything larger than a rat.

2. "On Pituri, a new Vegetable Product that deserves further Investigation," by S. M. Curl, M.D. (*Transactions*, p. 411.)

Dr. Newman said that very little was known as to the real merit of this plant. It was no doubt, to a certain extent, a stimulant, but he thought a great deal was due to imagination. He could not agree with many of the author's statements as to the power of this product, especially in critical cases of disease.

Mr. Kirk explained that Dr. Curl only suggested that the plant might prove useful in critical cases, not that it had done so. If what the author said was correct, it would be a most valuable drug to travellers and explorers in New Zealand.

Mr. Field would like to have the Chairman's opinion as to whether the experiments on animals referred to could be attributed to imagination.

Dr. Newman said that no doubt the plant had an effect on animals, as it was an unusual food for them. It was only in the case of experiments on human beings that at all reliable results had been obtained, and these latter were to him unsatisfactory.

3. "Some Remarks on Dr. Curl's 'Notes on Grasses and Fodder Plants, suitable for Introduction to New Zealand,'" by Henry Blundell.

ABSTRACT.

The author paid a high compliment to Dr. Curl for his work. He thought that though rye and clover were often selected as the best known grasses for the cultivator, the pasture grown from them is mixed with other grasses, owing to the difficulty of getting pure seed. Several grasses thus get root in the ground, and in course of time the pasture, though nominally of one or two varieties, is actually composed of many. The author thinks a variety of food for cattle is most beneficial, if not essential, and says the effect of their food is especially noticeable in dairy produce. In this country *Phormium* has a great influence in the flavour of milk, and is largely chewed by cattle, especially the lower end of the leaf. The author has known acres of swamp land to be cleared of *Phormium* by cattle tearing off the leaves. He says "there is one exotic plant which I think is deserving of more than the passing notice it receives at Dr. Curl's hands in his paper published in Vol. IX. of the Transactions. I allude to the burnet, which grows luxuriantly in swampy soil, and thrives well in soil of a much drier description. Some of it was sown at the rear of the homestead, on a run where it throve wonderfully, but never spread, for the simple reason that the sheep never gave it the chance, for though naturally wild and timid they would brave a good deal to get a taste of the

burnet. Having grown some in a garden, I was anxious to introduce it among the native grasses in a low-lying paddock, which had never been ploughed, and was never likely to be, on account of the floods which periodically submerged it, and with that object I transplanted a few roots to different spots, and also sowed some of the seed in small patches, which were carefully marked. The roots struck readily, and the seed soon sprang up, and I congratulated myself on the success attending the experiment; but I failed of my object in substituting burnet for inferior plants through the sheep feeding it down close to the ground so that it could not seed. The author concludes with a suggestion to the Society to publish a pamphlet on such exotic grasses as have been proved suitable for specified soils and climates.

Mr. Travers remarked that Mr. Blundell could get a great deal of the information he mentioned as to grasses, etc., from the catalogues published in England. What we wanted here was the feeding value of grasses and character of soil. As to the disappearance of flax, he considered that the opening up of the swamps where it grows, by cattle, and the introduction of other plants, did more to make it disappear than merely the cattle eating it. It was, no doubt, eaten for the pleasant bitter it contained.

Mr. Kirk remarked that some confusion existed with regard to the burnet; there are two plants well known to agriculturists under the names of the greater and the lesser burnet respectively. The former flourishes best in cool and rather moist soils, the latter in those of a dry character; and he had observed the latter in a naturalized condition near Castle-rock and in other parts of the colony. Both plants are of great value. He considered the consolidation of the surface of swampy ground by cattle, and the consequent establishment of exotic weeds, to be more destructive to *Phormium* and other swamp plants than the direct injury caused by cattle in feeding, etc. He regretted that he could not agree with the author in his estimate of the value of Dr. Curl's writings. His statements were for the most part wanting in the necessary data for testing their value. He trusted Dr. Curl would furnish the results of the analysis to which he referred, with particulars as to the nature of soil in which the grasses were growing, course of culture, and quantity of food furnished by each, in precise terms, at some future time.

Dr. Newman agreed with Mr. Kirk that the information contained in Dr. Curl's papers on these subjects was scarcely full or complete enough to be of much practical value.

Mr. Blundell, in reply, said he did not think it necessary for him to defend Dr. Curl He still thought he was right in what he said about the disappearance of the *Phormium.*

4. "Notes on the Botany of Waiheke, Rangitoto, and other Islands in the Hauraki Gulf," by T. Kirk, F.L.S. (*Transactions*, p. 444.)

Mr. Travers said that it would be impossible not to remark the peculiar vegetation of Rangitoto as described by Mr. Kirk. The cause of the luxuriance of growth is no doubt due to the moisture of the climate.

Mr. Travers drew attention to a paper by Professor Houghton, of Dublin, on "Physical Geology," lately published in *Nature*, which bore out certain remarks made in a paper on the same subject written by him (Mr. Travers) last year, and published in Vol. X. of the Transactions.

Sixth Meeting. *9th November*, 1878.

John Carruthers, M. Inst. C.E., Vice-president, in the Chair.

Dr. W. L. Buller, C.M.G., was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of "The New Zealand Institute Act."

The nomination for the election of honorary members of the New Zealand Institute was made in accordance with statute IV.

1. "An Account of Improvements on Miramar Peninsula," by J. C. Crawford, F.G.S.

ABSTRACT.

The author stated that in 1840 the Peninsula was covered by a thick vegetation of fern, flax, toitoi, and shrubs, a few patches of bush being still on the ground. Burnham Water was then a sheet of water about 200 acres in extent.

In 1846 he decided to drain Burnham Water, and in 1847 accepted a tender to drive a tunnel through the ridge between Evans Bay and the Lagoon, since any drain made towards Lyall Bay would have been liable to be choked by blown sands during southerly weather. When the tunnel was completed drains were cut through the swamp.

The land when drained was very sour at first, and the sandy parts required time to gather vegetation before further operations could be carried on to advantage; but as the drainage proceeded, grass-seed was sown, and a good sward has now been obtained in most places. He estimates the cost of drainage, from first to last, at £3,000.

With regard to fixing the sands, the author states that he sowed seeds of *Ammophila arundinacea* and *Elymus arenarius*, and for several years believed the experiment to have been a failure; he, however, eventually found a few plants of *Ammophila*, and by continual planting succeeded in fixing a good deal of the sand. He states that the *Elymus* which he sowed was a failure, but that some plants subsequently procured were in some respects superior to the *Ammophila* for fixing blown sands.

Mr. Martin Chapman said that no doubt the drainage would in time be of great use, but at present he had noticed that in dry weather there was a thick deposit of salt on the land.

The Chairman remarked that several drainage schemes of a similar kind had been undertaken in New Zealand, but few had succeeded. He only hoped Mr. Crawford would be more fortunate.

Mr. Kirk considered that the information given regarding the fixing of the sand would be most useful. Mr. Crawford had paid particular attention to the planting with a view to its spreading. If he could now sow wheat or some other plant between the grass a thick sward would in time form. He thought the salt deposit mentioned only occurred in that portion where the lake had been. He was of opinion that the work performed would be highly remunerative.

2. "Further Contributions to the Ornithology of New Zealand," by Walter L. Buller, C.M.G., Sc.D. (*Transactions*, p. 366.)

Dr. Newman said he would like to be informed whether the New Zealaud harrier was in the habit of catching fish. Dr. Buller had referred to its repugnance to water; but he wished to state that in Hawke Bay District he had frequently found this hawk devouring large eels in the neighbourhood of the swamps. Others had observed the same, and it was evident that this bird, which was constantly hovering about the swamp vegetation, was in the habit of catching eels. As to the kingfisher, he was surprised to hear that Captain Hutton had ever contended that this bird did not feed on fish. Everyone who had observed its habits would agree that it was most active in pursuit of small fish.

Mr. Martin Chapman said that in regard to the kakas which perished in their passage across the Strait, he believed it would be found that it was the lean-conditioned bird, and not the fat one, that succumbed. He instanced the case of wild turkeys in America. They were known sometimes to cross rivers on the wing, and on these occasions the thin emaciated birds often fell into the water and were drowned. As to the piscivorous habits of our kingfisher mentioned by Dr. Buller, he could aver from personal observation that the New Zealand bird was an undoubted fish-hunter. He had actually seen one, after dropping a fish that it had captured, return and pick it up again.

Dr. Buller, in reply, stated that the harrier, like many other birds, is very averse to wetting its plumage, and never hunts in the water. But, being a carrion-feeder, it may constantly be seen hovering over the sea-beach, and devouring the dead bodies of cast up fish, etc. Eels are known to travel considerable distances overland in search of new ponds, and during such migrations would, of course, be exposed to the attacks of the hawk. He thought that the circumstance mentioned by Dr. Newman might be accounted for in that manner, for the helpless eels on dry ground would be very apt to fall a prey to this ever-vigilant hawk. As to the kakas cast ashore in Golden Bay, he could state on the authority of his informant that in every case the birds picked up were excessively fat, and it was a well-known fact that at certain seasons of the year the kakas became so incommoded with fat as to be scarcely capable of flight. A correspondent informed him that on one of these occasions he actually caught with his hands in the course of a single day eight of these over-fed kakas, as they were positively unable to fly at all.

Dr. Newman said that his experience of eels was that they only travelled when their pools became dry, and in the district to which he referred the lagoons were always full of water. He thought one of the most interesting facts in New Zealand ornithology, brought out in Dr. Buller's papers, was the frequent recurrence of albinoes. Almost every species showed a tendency in some degree to albinism, and this was certainly a very remarkable and inexplicable thing.

3. "On Osomose as the Cause of the persistent Suspension of Clay in Water," by W. Skey, Analyst to the Geological Survey Department. (*Transactions*, p. 485.)

4. "On the Nature and Cause of Tomlinson's Cohesion Figures," by W. Skey. (*Transactions*, p. 490.)

5. "On some New Zealand *Aphroditæ*, with Descriptions of supposed new Species," by T. W. Kirk, Assistant in the Colonial Museum. (*Transactions*, p. 397.)

Mr. Field wished to know whether the beautiful colours mentioned were preserved after death; and the author stated that the specimens exhibited on the table would prove that they were retained to a great extent.

Dr. Buller said that it was gratifying to find one of the members taking up this branch of zoology, and he hoped the author would continue his useful work.

6. "Notes and Suggestions on the Utilization of certain neglected New Zealand Timbers," by T. Kirk, F.L.S. (*Transactions*, p. 458.)

Mr. Field was glad that attention had been drawn to this subject. He had been assured by a French gentleman now preparing a work on the subject, that a ready market could be found for these ornamental timbers in Paris.

Mr. J. T. Thomson considered that great difficulty would be experienced in preserving our timbers. The settlers do not care about moving in the matter, and if done at all it must be done by Government. It would, he thought, be difficult to utilize these timbers to the extent pointed out. He did not think the destruction to our forests was so great as was supposed; the blue gum would in a great measure replace them.

Dr. Buller gathered from the paper that what the author particularly wished to advocate was the establishment of a trade in ornamental timbers between New Zealand and Europe; and from his experience he thought there would be no difficulty whatever in carrying this out. The conservation of the forests would follow as a matter of course.

Mr. Knorpp stated that he had been enabled to bring these timbers prominently before the continental people, as he had exhibited a piece of work at the Paris Exhibition, made by Mr. Seuffert, of Auckland, and he understood that it had been so much admired that it had been awarded a medal. He had a considerable quantity of rewarewa and totara knots now in Wellington, which he would gladly give up to anyone who would undertake to send them either to Paris or London as an experiment, and he would assist them in any way he could in opening up a trade in this direction.

Mr. W. R. E. Brown asked if the white pine cut fresh here, and sent away, would still be subject to the destructive insect; and the author explained that he was of opinion that the insect only attacked white pine that was cut out of season. Mr. Kirk further stated in reply that he did not think any amount of planting we could do should prevent us from conserving our forests. There were no forests of blue gum that he knew of to make up for the destruction. No opposition on the part of settlers should prevent the forests being protected. It must be done sooner or later, and the sooner the better for all concerned.

The Chairman admitted that the destruction was great, but agreed with Mr. Thomson as to the difficulty of stopping it. An able report had been made on the subject by Captain Campbell-Walker, but nothing had come of it. If it were looked at as the property of the whole colony, then something might be done. He did not think dry rot could be stopped, unless the timber were floated; he found that answer in India. None of the plans for preserving timber mentioned would, he thought, be successful, except the application of creosote, and that was too expensive. The beauty of New Zealand timber had been exaggerated. None of it could compare with mahogany, walnut, and several others. He did not think so much of the kauri as others did. The high rate of interest is against the establishment of a timber trade, as proposed, between this and other countries.

The Chairman drew attention to casts of a Maori idol, procured from the natives in the North by Sir George Grey, which was very interesting owing to its bearing such a resemblance to idols found in other islands far from New Zealand.

Mr. John Kebbell also explained the working of a gas-lamp which he had constructed with a view to enabling one uniform temperature to be kept up in any room.

The lamp in question had been prepared for the clockroom at the Observatory.

Seventh Meeting. *30th November*, 1879.

J. Carruthers, M. Inst. C.E., Vice-president, in the chair.

1. "On the Cleansing of Towns," by J. Turnbull Thomson, C.E., F.R.G.S., F.R.S.S.A., Surveyor-General of New Zealand. *(Transactions*, p. 38.)

Mr. Field thought that credit was due to Mr. Thomson for bringing before the New Zealand public in a concise and handy form the opinions of Sir John Bazalgette and other eminent English engineers. He regretted, however, that the Surveyor-General had not made any allusion to the sewage farm and irrigation works of Bedford, a town which in point of size as well as in many other particulars closely resembled the City of Wellington. As was well known, Mr. Climie had, in his report, recommended that the sewage of the whole city should be discharged on the low land at the south-west corner of Evans Bay. Mr. Clark also had, in general terms, agreed in this opinion. But various objections were raised, and hitherto nothing had been done. He remembered, when he was last in Bedford, in the autumn of 1876, carefully going over the sewage farm, and being much pleased with the excellent system of drainage in that town. Previous to the year 1868 the beautiful river Ouse had been poisoned by imperfect drains; but for the last eight or nine years a complete system of water, sewerage, and irrigation works had been in existence, with highly satisfactory results. Through the centre of the town ran one main sewer, receiving in its course the discharge of the lateral drains, and emptying the whole into a tank 17 feet deep, from which it was pumped up and distributed by pipes over the irrigation farm. This farm of 180 acres was rented by the Corporation at the high rate of £1,000 (about) per annum, but this charge was more than repaid by the produce, which, on the lowest average, would sell at more than £1,500, in addition to which some grass land was sublet for £200, thus bringing the total annual receipts to £1,700 odd. Italian rye grass and roots of various descriptions formed the principal crops, and grew with a remarkable luxuriance. As to what had been said with regard to the stench arising from sewage farms, he could from personal observation assert that Mr. Thomson was entirely mistaken, and that, except in very rare instances, no offensive odour could at any time be detected.

Mr. O'Neill considered the paper a very valuable one, but hoped there would be an opportunity afforded of renewing the discussion; the subject was a very wide one, and he was not prepared to enter upon it on the present occasion.

Dr. Newman said that very little real progress had been made in the last ten years in our sanitary knowledge. A great deal was talked and written about the subject, but no fresh light had been thrown on the matter for some years past. He thought the subject was talked threadbare. All our experience had taught us was that there were only two systems—the wet and the dry. In the Sahara and similar districts the wet system was impossible, but where, as in Wellington, there was abundance of water and good outlet, there was no question but that the only way was to cast it into the sea. A sewage farm had never yet been made to pay. It was a great error to suppose that sewage was very profitable; it was really almost valueless, and the products of precipitation not worth the cost of carting. Food, such as bread and meat, etc., if buried, might aid the growth of strawberries and melons, but if eaten and passed through that laboratory, the human stomach, it became disintegrated, chemically changed, and the sewage was almost worthless. One modern improvement was the use of cement pipes instead of earthenware pipes.

Mr. J. P. Maxwell asked if the cost of the sewage farm at Croydon, which was stated to be about £1,000 per annum, included interest on the outlay incurred in carrying out the drainage of the town? He thought it did not, but that it was in addition to interest. It was important to make this doubtful point clear. The table attached to the paper gave the cost of irrigation at Banbury, a town of 12,000 inhabitants, at about £150 per annum. This of course could not include interest.

The Hon. Mr. Waterhouse thought Mr. Thomson's paper of great value. In spite of Dr. Newman's remarks, he believed the time was not far distant when people would look back with surprise at the present extravagant and wasteful system of dealing with sewage. He thought the chief objection to sewage farms was the small scale on which they were managed. Not being large enough, they very soon became "manure sick," and consequently proved a failure.

The Chairman said he thought it could not be said there were two systems of sewage, the wet and the dry. There is a certain quantity of water brought into a town clean, and nearly the same quantity goes away foul; it is necessary to have a system of sewers to carry it. As the water-closet ejecta only constitute one per cent. of the nastiness of sewage, there is no advantage in having a separate dry system for the sake of it, and if there is one it does not lessen the need of having a wet system too. All the dry systems are objectionable on account of smells, and should be as much as possible avoided. The value of sewage for agricultural purposes was nearly nil, and none of the chemical processes, and not even the irrigation process, could get what there was out of it. The effluent water was quite as valuable as the sewage itself. He therefore recommended when possible to throw sewage into the sea. As regards the sewage of Wellington, he thought it would be waste of money to incur great expense in taking it to the sea, as it would not create a sensible nuisance in the harbour.

Mr. J. T. Thomson, in reply, stated that the subject could not be done with, but would call for continuous attention. With regard to excreta as a manure he could bring forward 17 years' experience in support of its value, as he had seen it used and applied by the Chinese in Eastern Asia. He could not agree that no improvement had taken place during these last ten years in sanitary science, the better condition of cities being the proof to the contrary. He had indicated where the separate systems were applicable, and held a different estimate of the value of the labours of the Glasgow deputation to what one of the speakers did. Even that gentleman had supported their deductions in reference to the utilization of sewage. The evidence was that the poorer classes of Europe could not be brought to use the water system; it conld therefore not be universal. At Crossness he found the water of the Thames very filthy. He agreed with Mr. Carruthers in his report as to the outfalls for Wellington, viz., that they should be at points in the harbour not over one mile from the outskirts. But in his paper he purposely avoided bringing in local topics, as tending to deteriorate from an unbiassed position.

Eighth Meeting. 11*th January*, 1879.

A. K. Newman, M.B., Vice-president, in the chair.

New Members.—J. Brown, W. France, G. J. Binns, George Ashcroft.

1. "List of Plants collected in the District of Okarita, Westland," by A. Hamilton. (*Transactions*, p. 435.)

2. "Notes on Mr. Hamilton's Collection of Okarita Plants," by T. Kirk, F.L.S. (*Transactions*, p. 439.)

3. "Note on a curious Duplication of Tusks in the common wild Pig *(Sus scrofa)*," by A. Hamilton.

My attention was drawn the other day to a curious jaw, with double tusks, of a pig that had been killed at the Waipapa Creek, near Mohaka. As will be seen by the accompanying sketch the development has not been symmetrical, the two tusks on the left side being of normal shape, and measuring from tip to insertion, three inches, and total length seven and three-quarter inches.

On the right side the lower tusk is only two inches from point to insertion, but the basal portion has been displaced and turned inwards by a most peculiarly shaped tusk, which turns inwards and upwards till the point is as far as the central line of jaw. The end has been worn down to the shape of a finger nail by the roof of the mouth, and, judging by the rounded surface of the incision, the animal must have been unable to close its mouth properly.

Unfortunately the upper jaw was not preserved; it must have been curious, as the lower molars are very irregular and worn entirely on the inner side.

There is a small supplementary tooth under the second incisor on the right side.

Dr. Newman thought more notice should be tåken of such monstrosities. Evolution taught us that such monstrosities were nearly all reversions to some old type, showed the ancestry of the animal, *e.g.*, children who breathed through their necks, branchial clefts, like their amphibious ancestors. Everyone at a certain time of life had two sets of teeth in his or her jaw, and one specimen in the Hunterian museum had three sets. One odd, useless structure had never been explained, viz., the corn on the inside of a horse's forelegs.

Mr. T. Kirk pointed out that the monstrosity described by Mr. Hamilton was an instance of duplication combined with distortion, and could hardly be explained by the supposition that it was an instance of reversion to a remote ancestral type—a theory which was now being pushed to extreme lengths.

4. "On the Export of Fungus from New Zealand," by T. Kirk, F.L.S. (*Transactions*, p. 454.)

5. "Description of a new Species of *Lycopodium*," by T. Kirk, F.L.S. (*Transactions*, p. 456.)

6. "Description of a new Species of *Hymenophyllum*," by T. Kirk, F.L.S. (*Transactions*, p. 457.)

Specimens illustrating these papers were exhibited.

7. "Note on Mr. Howard Saunders' Review of the *Larinæ* or Gulls," by W. L. Buller, C.M.G. (*Transactions*, p. 359.)

8. "Notes on a new Species of *Pomaderris (P. tainui)*," by Dr. Hector. (*Transactions*, p. 428.)

Mr. Kirk spoke of the discovery as being of great interest, but was inclined to believe the plant would prove identical with an Australian species, notwithstanding its larger size. In other parts of New Zealand the natives had traditions that certain trees were the paddles or canoe poles which had been fixed in the ground on landing, and had taken root; and as the genus *Pomaderris* was restricted to Australia and New Zealand, he feared that we could not expect to find the plant discovered by Dr. Hector in other countries.

Mr. Buchanan thought that if the plant was a new species we were as much in the dark as ever, and that if it proved to be identical with the Australian species, it would upset many pet theories with respect to the "Whence of the Maori."

9. "Notes on some New Zealand Crustaceans," by T. W. Kirk, Assistant in the Colonial Museum. (*Transactions*, p. 401.)

10. "Description of a new Species of *Celmisia*," by J. Buchanan, F.L.S. (*Transactions*, p. 427.)

11. "On the Fossil Flora of New Zealand," by Dr. Hector, Director of the Geological Survey.

ABSTRACT.

This paper gave a prodromus of a work on the fossil flora of New Zealand, containing descriptions and figures of about a hundred species. The earliest traces of plants found in the New Zealand rocks are in the upper Silurian formation, but these and also the plant remains found in the *Devonian* and lower *Carboniferous* strata are very obscure, and no structural features have yet been identified.

The earliest recognized forms are *Glossopteris* and *Schizoneura*, which occur about the middle of the Kaihiku formation, overlying marine fossils that have a mixed Carboniferous and *Permian* facies.

In the Wairoa formation of Triassic age, fragmentary plant remains are abundant. *Dammara* occurs, the wood having been identified from its peculiar structure by Prof. Unger*; also, fronds that are referred to—*Zamites* and *Neuropteris*.

The next horizon with plants is in the Flag Hill series, which is the lower of the three divisions of the Jurassic, and the following forms indicate an extension of the Indian flora of the same period far into southern latitudes. *Macrotænopteris lata*, *Palæozamia mataurienis*, *Oleandridum vittatum*, var., *Alethopteris* (two species), *Pecopteris* (three species), *Neuropteris stricta*, *Camptopteris novæ-zealandiæ*, *Cycadites*, and *Echinostrobus*. A closely-allied flora to this re-appears in the Mataura series, which is the upper member of the Jurassic formation.

The Neocomian strata (or Amuri series) which are so rich in the remains of fossil reptilia, are interesting from their affording the earliest specimens of a true *Dicotyledonous* leaf, associated with the foliage of *Dammara* and *Araucaria*.

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* Hochstetter's New Zealand, p 57.

In the Cretaceous formation occur the great coal deposits in New Zealand. The associated flora, which is very rich in forms, has a large preponderance of Dicotyledonous plants some of which have been referred to generic representatives of the existing flora of this country, forty different species being distinguished.

The upper Cretaceous and Eocene formations (Cretaceo-tertiary) are blended and continuous in sequence and altogether of marine origin ; but in some districts the sections are incomplete in their lower sub-divisions, and the coal series, if present, is overlaid immediately by one of the upper sub-divisions, indicating a probable continuity of land surface in some parts of the area throughout the entire period.

In the Miocene there is again evidence of wide-spread land surfaces in the South Island, at the base of the great gravel deposits that represent all the subsequent formations in that area ; but in the North Island the Miocene and lower Pliocene formations are marine, the upper Pliocene being a lignitiferous series, associated with pumice sands. The flora of the tertiary period is badly preserved, and the collections are scanty ; but as far as yet studied, it bears a very close affinity to the recent flora of the country.

12. "On the Fossil *Brachiopoda* of New Zealand," by Dr. Hector.

ABSTRACT.

The lower, secondary, and upper Palæozoic formations of New Zealand, afford a remarkable abundance of Brachiopoda belonging to the family *Spiriferidæ*, and the examination of them has led to the discovery of several forms, possessing characters hitherto undescribed, and has, besides, proved that several well-known genera have a much greater vertical range than has hitherto been assigned to them.

Thus the peculiar sub-genus of Terebratula represented by the typical *Epithyris elongata*, which has previously been recorded only from Permian and Carboniferous strata, is abundant in the Liassic (Bastion) series, and extends downwards to the upper Silurian formation.

In dealing with those Spiriferidæ distinguished by the possession of a punctate shell structure and a strong mesial septum in the ventral valve, it has been found convenient to restrict the genus *Spiriferina* to the middle secondary forms, having rounded cardinal angles, and a moderately extended hinge-line as in *Spiriferina walcoti*, and *S. rostratus*, while Professor König's name of *Trigonotreta* has been revived for the Permian species, in which the hinge-line is greatly produced, and forms acute processes, as the New Zealand forms clearly support the generic distinctions relied on in Professor King's monograph on the Permian Fossils of England. Thus, while the general form is that of *Spirifera*, the shell shows a distinctly punctate

structure, and the internal casts show that a strong septum divided the prominent ventral beak into two cavities.

A third form related to *Spiriferina* in having a punctate shell-structure, differs so essentially as to require separation as a genus, to which the name *Rastelligera* has been applied, from the peculiar character of the hinge-line, which is enormously long in proportion to the height of the shell, and along the hinge-margin both valves are minutely denticulate, with rake-like teeth that appeared to interlock. The proper dental processes are only feebly developed, if not altogether absent, and both valves are nearly equally convex. The genus *Rastelligera*, of which there are several species, is limited to the Wairoa series (Triassic), and the Otapiri series (Rhætic).

The next form, which is like *Spiriferina* in general outline, although in different species it varies greatly in the extension of the hinge-line, has a marked peculiarity in the arrangement of the dental plates, which spring from the sides of the mesial septum, so that a horizontal section of the beak, or the fissures seen in the natural internal cast, show the interior processes to have been arranged like the Greek character ψ, from which the name *Psioidea* has been given to the genus. Some of the species are remarkable for the great development of a concave triangular area, overhung by a strongly projecting dorsal umbo. This genus has been discovered in the Silurian formation, and finally disappears in the upper part of the Rhætic beds.

Besides the above, which are all allied to *Spiriferina*, true forms of *Athyris (Spirigera)* are not uncommon from the Triassic formation downwards; but in the same formation, and in the overlying Rhætic (Otapiri) series, *Athyris* is only represented by an allied genus, having also a lamenellate shell-structure, but possessing characters that have required its separation under the generic name of *Clavigera*.

This form agrees with *Athyris* in having the ventral beak foraminate and in the apices of the spire-cones being central and directed to the middle of the lateral margins, and not to the cardinal angles as in *Spirifera*. But it differs in the possession of a distinct area and fissure under the beak, and a long, straight hinge-line, in which respect it resembles the *Spirifera*. Its most obvious peculiarity is that both valves are almost equally convex, and that both are sulcate in the median line, and that both a foramen and a fissure are present in the ventral valve, which is a most exceptional character among *Spiriferidæ*. The name has been given on account of the strong stud-shaped cardinal boss, which in the cast gives rise to a singular hood-like process, owing to the matrix that lodged between the interior surface of the dental-plates and the boss having been preserved after the shell has weathered out.

The genus *Spirifera* proper is met with in the lower Carboniferous (Maitai) series and downwards, but its description does not fall within the scope of this paper.

These two papers will appear in full in the reports of the Geological Survey Department, now in the press.

13. "Catalogue of the hitherto-described Worms of New Zealand," by Professor F. W. Hutton, C.M.Z.S. (*Transactions*, p. 314.)

ANNUAL GENERAL MEETING. *1st March*, 1879.

T. Kirk, F.L.S., President, in the chair.

Minutes of last Annual General Meeting read and confirmed.

New Members.—D. M. Luckie, G. Beetham, M.H.R., W. Kemp, M.R.C.S., W. H. Triggs.

ABSTRACT REPORT OF COUNCIL.

During the year nine general meetings were held, at which 43 papers were read.

Two conversaziones were held, at each of which about 400 visitors were present, and the Council acknowledge the assistance of many gentlemen who lent objects of interest, and especially the Governors and Manager of the New Zealand Institute for lending the colonial museum.

The total number of members is 252, of whom 31 were elected during the year.

Eighty volumes have been added to the library.

It is with regret that the Council record the death of Mr. W. Lyon, F.G.S., and Mr. John Kebbell, both very old and valued members of the society. The late Mr. Lyon contributed largely to the library by donations, and until lately took an active part in the work of the society. The late Mr. J. Kebbell has been a frequent exhibitor of ingenious adaptations of scientific apparatus, and during the past year brought before the members several modifications of the telephone and microphone, and an excellent arrangement for regulating the temperature of astronomical observatories.

The statement of accounts showed that the total receipts of the year were £314 7s. 2d., and that there is a balance in hand of £103 5s. 9d., while a sum of £35 17s. 6d. (being one-sixth of the nett income) has been handed to the New Zealand Institute in compliance with the statute.

ELECTION OF OFFICERS FOR 1879.—*President*—A. K. Newman, M.B., M.R.C.P.; *Vice-presidents*—Dr. Hector, Martin Chapman; *Council*—W. L. Buller, C.M.G., Sc.D., etc., C. R. Marten, F. W. Frankland, S. H. Cox, F.C.S., F.G.S., Hon. G. Randall Johnson, W. T. L. Travers, F.G.S., T. Kirk, F.L.S.; *Auditor*—Arthur Baker; *Secretary and Treasurer*—R. B. Gore.

The retiring President then delivered the following Anniversary

ADDRESS.

It is expected that your President, on the expiry of his term of office, shall lay before you some account of the scientific work effected by the members of the society during the past year. Unhappily, circumstances, over which I had no control, prevented my attendance at several meetings,

so that I am not in a position even to form an opinion on several papers. Moreover, amongst the titles of those papers, simply taken as read, are one or two which doubtless belong to the most valuable portion of the year's work. I refer more particularly to those on Fossil *Brachiopoda*, and on the Fossil Botany of New Zealand, by the Director of the Geological Survey Department; for these and other reasons I shall request your permission to depart from the usual course, and to occupy a portion of the evening with a few remarks on a single subject—the connection between the Floras of New Zealand and Australia.

On the Relationship between the Floras of New Zealand and Australia.

The vast difference between the area of these two countries necessarily involves a great disproportion between the number of species in their respective floras, so that no great amount of surprise is experienced on finding the attention at first arrested by the series of strong contrasts which they present rather than by prominent proofs of affinity. Nearly three-fourths of the Australian forest consists of *Eucalypti*, of which there are fully 140 species, comprising the loftiest trees in the world, but the genus is not even represented in New Zealand. Again, 600 species of Proteaceous plants, *Banksia*, *Grevillea*, *Hakea*, *Isopogon*, *Persoonia* etc., impart a peculiar character to the scenery of many Australian districts, but only two species of the order are known in New Zealand. Australia possesses nearly 1,000 species of Leguminosæ, which contribute largely to the physiognomical character of its landscapes, or add to its floral beauty. New Zealand has only some thirteen species, none of which are important. On the other hand, the characteristic genera of the New Zealand flora are either absent or but sparingly represented in Australia, so that they do not form prominent features in its flora. The extensive forests of *Nesodaphne*, *Fagus*, and *Podocarpus*, so characteristic of this colony, are rarely met with in Australia, and none of the species are identical. *Coprosma*, which forms so large a portion of the undergrowth throughout the colony, and comprises some twenty-five species, is but sparingly represented in Australia, where the genus is limited to five species, its place there being partly occupied by *Opercularia*. *Dacrydium*, which is more highly developed in New Zealand than in any other country, and ranges from the sea-level to the extreme limit of ligneous vegetation, is restricted to a single species in Australia, the famous Huon pine of Tasmania. *Celmisia*, a remarkable genus of Asters comprising some thirty species, distributed from the North Cape to the Bluff, and ascending from the sea-level to the highest limits of vegetable growth, is represented in Australia by a single species common to both countries. *Metrosideros*, which, in one form or other, is an important factor in all forest vegetation, is limited to a single species of no great importance in Australia.

This contrast might be carried much further, but my object is to show the relationship between the two floras rather than their dissimilarity. Before proceeding with this subject, however, it will be convenient to state two facts which it is desirable to keep in mind. The superficial area of New Zealand is rather less than 100,000 square miles; that of Australia, including Tasmania, is upwards of 3,000,000 square miles. No part of New Zealand extends north of the thirty-fourth parallel of latitude, while fully two-fifths of Australia are within the tropic of Capricorn. Further, it cannot be doubted that a much larger proportion of new species remains to be added to the flora of Australia than to that of New Zealand, and it is chiefly among the species yet to be discovered in this colony that we must expect to find further indications of an ancient connection between the two floras.

Both assemblages of plants now under consideration have one broad feature in common. The great majority of species in each is endemic, and consists of plants that have originated within the geographical limits of either New Zealand or Australia, as the case may be; but notwithstanding this there is a direct relationship between them. Not only are many plants common to both, but others plentiful in one country are represented by closely-allied species in the other.

The number of species known to be common to both countries is—Dicotyledons, 143, belonging to 92 genera; Monocotyledons, 95, belonging to 60 genera; Filicales, 87, under 30 genera. Of these 120 species are not known to occur elsewhere.

If, however, we look at the total number of genera common to both countries, we shall see that the relationship is much closer than it appears to be from a simple consideration of the number of species common to both. Here we find:—

	Dicotyledons.	Monocotyledons.	Filicales.
Genera ..	169 ..	76 ..	33

So that in addition to the 181 genera containing species common to both countries, there are 96 genera represented in each country by different species. Leaving the Filicales out of consideration for the present, nearly five-sixths of the Phænogamic genera of New Zealand are common to both countries. I do not at present draw attention to those genera in one country which take the place of closely-allied genera in the other, but will simply state that all the natural orders represented in the New Zealand flora are also represented in Australia, with the exception of *Coriarieæ* and *Chloranthaceæ*.

It would, however, as was long since pointed out by Sir Joseph Hooker, be wrong to infer from this that the flora of this colony is little more than an offshoot from that of Australia, since there is no other instance in which

two contiguous countries exhibit such wide differences between their respective floras. Many of the characteristic genera of Australia are represented in New Zealand by one, or perhaps two, species common to both countries, but not found elsewhere ; but exactly the same phenomenon is exhibited in Australia by characteristic New Zealand genera. Amongst the former may be named *Pomaderris elliptica*, *Leucopogon richei*, *Leptospermum scoparium*, *Poranthera microphylla* ; amongst the latter *Coprosma pumila*, *Celmisia longifolia*, *Senecio lautus*, *Pimelea longifolia*. It is evident, therefore, that a portion of the Australian flora has been derived directly from this country.

It will be advisable to indicate the chief points of interest connected with the species and genera common to both countries without going into detail to any great extent.

Ranunculaceæ.—*Clematis* is common to both countries, but the species of each are endemic. In *Myosurus*, a genus of two species, it is worthy of note that the European form is found in Australia ; the American form in New Zealand. *Ranunculus* is represented by twenty-six species in New Zealand and eleven in Australia, of which five are common to both countries. Three of these are not found elsewhere. *Caltha* is represented by a single endemic species in each country. The larger order Cruciferæ which is sparingly represented in this colony, contains three species common to both countries, but of wide distribution, and a fourth not found elsewhere. One of our violets extends to Tasmania, and *Hymenanthera* is represented by a single species in each country. Pittosporeæ, an order of which all the genera, except *Pittosporum*, are restricted to Australia, is represented in New Zealand by sixteen species of *Pittosporum*, all of which are endemic. Caryophylleæ comprises three genera and four species common to both countries. In Malvaceæ, *Plagianthus* is restricted to these countries, but has no species common to both. Both countries possess two species of *Hibiscus* of wide distribution.

In Lineæ, *Linum marginale* is the only common species, and does not occur elsewhere. *Geraniaceæ* has three species of *Geranium*, one of *Pelargonium* and two of *Oxalis*, common to both countries. In Rutaceæ all our species are endemic, but belong to Australian genera. Meliaceæ is represented in both countries by a single endemic species of *Dysoxylum*, and Olacineæ by one of *Pennantia*.

In Rhamneæ, *Pomaderris*, a genus restricted to Australia and New Zealand, and specially abundant in cool regions of the former, is represented here by five species, three of which are common to both countries. *Discaria* has a single species in each country. Of Sapindaceæ only a single species of *Dodonæa* is common to both countries. The genus is more largely developed in Australia than elsewhere, but the New Zealand species is the most widely distributed of all.

Looking at the points of contact between the two floras afforded by Leguminosæ alone, the relationship appears but slender. This order, which stands second only to Compositæ amongst flowering plants in the number of species it contains, includes more than one-eighth of the Phanerogamia of Australia, where it comprises nearly as many species as are found in the entire Phanerogamic flora of New Zealand; yet, amongst the thousand Australian forms not one is common to both countries, a fact which is the more remarkable as the seeds of most plants of this order suffer less than others when drifted by marine currents. The seeds of *Entada scandens* are drifted from the shores of Northern Australia to the coast of New Zealand, and have been picked up even on the East Coast as far south as Tauranga. It is certainly matter for remark that no sea-borne seeds of *Acacia* or other large Australian genera appear to have germinated on the New Zealand coasts.

Three genera of this order, however, are common to both countries, and the first two are not found elsewhere. *Clianthus*, of which a single species is endemic in the extreme northern portion of New Zealand, and another in Australia, the first being a glabrous undershrub, the second a pilose herb. *Swainsonia*, which is represented here by a single species confined to the Southern Alps, and by numerous species in Australia. *Sophora* has two species in Australia and another in this colony, but belonging to a different section of the genus. *Carmichælia* and *Notospartium*, the only additional genera in New Zealand, are endemic, and have no near allies in Australia.

Both countries are characterized by a great paucity of Rosaceæ. In New Zealand we find four genera and thirteen species; in Australia, seven genera and seventeen species; four genera and four species being common to both.

In Saxifrageæ, the relationship is generic only. *Quintinia* and *Ackama* not being found elsewhere, and *Weinmannia* having a wider distribution.

Drosera is largely developed in Australia, where it comprises forty-one species, five of which extend to New Zealand, but with the possible exception of *D. spathulata*, are not found in other countries. In Halorageæ, four genera and eight species are common to both countries.

Myrtaceæ ranks next to Leguminosæ, in the extent to which it imparts a peculiar character to the Australian flora, but has only a single species common to both countries. *Metrosideros*, *Myrtus*, and *Eugenia* are represented by different species in each country.

Epilobium, a genus developed in New Zealand to a remarkable extent, has six species common to both countries, four of which are not known to occur elsewhere.

Of umbelliferous plants, eight genera and six species are common to both countries. The trimorphic araliads of New Zealand have nothing to represent them in Australia.

Coprosma, which forms so large a portion of the shrubby vegetation of this colony is but sparingly represented in Australia, two species are common to both countries, one of them however only occurring in Lord Howe's Island, on the Australian side. A species of *Nertera* is common to both countries.

Compositæ, the largest order of *Phænogams*, is less developed in Australia than might be expected; it comprises over five hundred species; in New Zealand it contains one hundred and fifty-five—nineteen genera and twenty species only are common to both countries; one-third of these are plants of wide distribution, and ten are not found elsewhere. *Celmisia*, a fine genus of mountain asters containing about thirty species, is restricted to New Zealand, with the exception of *C. longifolia*, which extends to the Australian mountains. *Olearia*, another large genus restricted to Australia and New Zealand, contains sixty-five species in the former country, and nearly thirty in the latter, but no form is common to both. *Brachycome* is restricted to these countries, but has no common species, and is most highly developed in Australia. The important genus *Senecio*, which is largely developed in both countries, has only one common species.

The remarkable Australian genus *Stylidium* is not represented in New Zealand. *Donatia novæ-zealandiæ* is common to both countries, and *Forstera* is represented in each by endemic species.

Of Heaths and Epacrids, eight genera and seven species, none of which are found elsewhere, are common to both countries.

A single olive is found in Australia, but does not belong to the section of the genus which comprises the New Zealand species.

* Of Scrophularineæ, Australia has thirty genera and over one hundred species. New Zealand has ten genera and sixty species, eight genera and nine species being common to both countries, but not found elsewhere. *Veronica* is represented by fifteen species in Australia, and forty-eight here; one of the Australian species belongs to the section with appressed imbricating leaves.

Nesodaphne, which enters so largely into the composition of the northern forests in this colony, is represented in tropical Australia by a single endemic species.

Tetranthera, *Atherosperma* and *Hedycarya*, are represented in both countries, but have no common species.

Proteaceæ stand next to Myrtaceæ with regard to their influence on the Australian flora; but of the six hundred species known to occur there, not

* I should perhaps mention the recent discovery in this colony of *Liparophyllum*, a monotypic genus of *Menyantheæ*, hitherto supposed to be restricted to alpine lakes in Tasmania, but the identification rests at present upon fruited specimens only.

one is indigenous to New Zealand, which, however, possesses two endemic species, one representing the nucumentaceous section of the order, the other the folliculaceous section; the former belongs to *Persoonia*, a genus largely developed in Australia, but not known elsewhere; the latter to *Knightia*, of which one other species is known in New Caledonia. The large genus *Pimelea*, restricted to New Zealand and Australia, comprises nearly seventy species in the latter country and ten in the former, but except *P. longifolia*, which extends from this colony to Lord Howe's Island on the Australian coast, no species is common to both floras.

Fagus, which forms so large a part of the mountain forests in New Zealand, is represented in Australia by three species, all of which are endemic.

In Coniferæ there is no species common to both countries; the common genera *Dammara, Podocarpus, Phyllocladus*, and *Dacrydium;* except *Podocarpus*, each is represented by a single genus in Australia, but *Phyllocladus* and *Dacrydium* are especially characteristic of New Zealand, the first having three species, one or other of which is found scattered throughout the colony except in the driest districts; the other contains seven species, some of which occur in all districts. In this, as in many similar cases, the Australian flora has been influenced by that of New Zealand rather than the reverse.

A much larger proportion of Monocotyledons is common to both countries, chiefly owing to the wide distribution of many species of Cyperaceæ and Gramineæ.

In Orchidaceæ there is a close generic relationship, no fewer than sixteen genera being common to both countries, but not more than six species, two alone of which are found elsewhere; the restricted distribution of the species of this order is strongly marked all over the world.

Astelia, a liliaceous genus largely developed in New Zealand, is represented in Australia by a single endemic species. Junceæ has eight species common to both countries, six of which are found nowhere else.

Twelve genera of Cyperaceæ, and thirty-two species, are common to both floras; many of the species exhibit a wide distribution, and not more than twelve are restricted to Australia and New Zealand.

In Gramineæ the relationship is still more strongly marked, more than half the New Zealand species, and twenty-five genera out of twenty-seven, being common to both countries; only ten of the species are restricted to these countries, many of them having a wide distribution.

In ferns and allied plants, the proportion of species common to both countries is still larger. Australia exhibits two hundred and thirty-two species, comprised under forty-seven genera; New Zealand has thirty-nine genera and one hundred and fifty-three species. Thirty-three genera

and eighty-seven species are common to both countries. All the genera are represented by identical species, with the exception of *Lygodium*, *Isoëtes* and *Pilularia*, but only twenty-one species out of the eighty-seven are restricted to the two countries. No endemic genus is found in Australia, but in New Zealand the beautiful *Loxsoma* is limited to the country north of the Hauraki Gulf. *Hymenophyllaceæ* are sparingly distributed in Australia, but owing to the humid climate of New Zealand, are abundant and luxuriant.

I purposely avoid going into detail on the various matters of debate raised by the statement now made, but will briefly summarize the chief conclusions to be drawn :—

1. That the New Zealand flora is more closely related to the Australian than to any other. Five-sixths of the genera, one-fourth of the species of Phanerogamia, and more than one-half of the ferns being identical.

2. That few or no Australian species have been added to the New Zealand flora, by means of aerial or marine currents.

3. The direct connection between Australia and New Zealand must have ceased (as stated by Professor Hutton from considerations based upon the distribution of Animalia), not later than the cretaceous period, or a larger proportion of Myrtaceæ, Proteaceæ, and other Australian types, would be found in the New Zealand flora.

4. The paucity of Rosaceæ and Labiatæ in both countries affords proof of the ancient isolation of both floras.

5. The occurrence of single species of the characteristic genera of either country in the other :—*e.g.*, of *Celmisia longifolia* in Australia :—of *Epacris purpurascens* in New Zealand—affords direct proof of the great antiquity of the species, and of its having attained a maximum of stability under the conditions which existed before the disruption of the connection between the two countries.

Dr. Newman, the President elect, thanked the meeting for the honourable position in which it had placed him, and assured the members that the new office-bearers would endeavour to do their best for the society during the coming year.

1. "On Barat or Barata Fossil Words," by J. Turnbull Thomson, F.R.G.S., F.R.S.S.A. (*Transactions*, p. 157.)

2. "Notice of the Discovery of *Calceolaria repens*, Hook. f., and other Plants in the Wellington District," by Harry Borrer Kirk; communicated by Mr. T. Kirk. (*Transactions*, p. 466.)

3. "Descriptions of new Plants," by T. Kirk, F.L.S. (*Transactions*, p. 463.)

AUCKLAND INSTITUTE.

First Meeting. 10*th June*, 1878.

The Rev. Dr. Purchas, in the chair.

New Members.—P. Dufaur, R. Horne, J. Horne, C. A. Robertson, G. Smith.

1. "On the *Histeridæ* of New Zealand," by Captain T. Broun.

According to the author, New Zealand possesses at least eight representatives of this family of Coleoptera, of which all, with one exception, differ from their congeners in other parts of the world in not being coprophagous in their habits.

2. "Notice of the occurrence of the Australian Genus *Poranthera* in New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 432.)

3. "The Maori Canoe," by R. C. Barstow. (*Transactions*, p. 71.)

Second Meeting. 15*th July*, 1878.

His Honour Mr. Justice Gillies, in the chair.

New Member.—S. M. Herapath.

The Secretary read the list of donations to the Library and Museum since the last meeting.

1. "The New Zealand *Anthribidæ*," by Captain T. Broun.

The author gave a list of the species known to occur in New Zealand, and also some information respecting the geographical range of the family.

2. "The British Arctic Expedition of 1875-76," by F. G. Ewington.

This was a short history of the expedition, together with a summary of the principal results obtained.

3. "Education as a Science." Part I., by C. A. Robertson.

Third Meeting. 12*th August*, 1878.

The Rev. Dr. Purchas, in the chair.

New Member.—T. Cooper.

1. "The *Cossonidæ* of New Zealand," by Captain T. Broun.

2. "Education as a Science." Part II., by C. A. Robertson.

Mr. Ewington spoke at some length on this paper. He objected to the author borrowing so largely from an article by Prof. Bain, in "Mind," without acknowledgment.

3. "*Æolus Vinctus*," by J. Adams, B.A.

This paper pointed out the serious faults existing in the present system of female education. In the opinion of the author, the course of study now adopted led to an undue cultivation of the emotional part of woman's nature, the intellect being comparatively neglected.

FOURTH MEETING. *9th September*, 1878.

T. Heale, President, in the chair.

New Members.—Rev. S. Edgar, E. A. Plumley.

1. Mr. Robertson made a lengthy defence of his paper, "Education as a Science," read at the last two meetings.

2. Mr. Heale spoke on Mr. Adams' paper on Female Education, read before the previous meeting. In a boy's education, the training should be almost purely intellectual. It is likely to be necessary for the success in life of every boy that he should be quick and apt at figures, that he should speak and write his own language with reasonable facility and correctness ; and if his education is to be carried beyond mere rudiments it is obviously necessary that he should have a grounding in mathematics, and in the elements of literature, which is necessarily based on classics; and also, some initiation into the elements of Physical Science. But with girls this sharp limitation of school teaching, to purely intellectual knowledge, has not been adopted. It has apparently been felt that the development of a moral character, and the cultivation of the æsthetic faculties, are generally of more importance to the well-being of a girl than the hardening and bracing of her reasoning powers; that elegance of language and demeanour, a nice tact in the avoidance of all that is base and sordid, a quick appreciation of and relish for what is beautiful—in short "accomplishments," even if of a somewhat flimsy and mechanical character,—are likely to be more appreciated by those she will associate with in her career, and therefore be more useful to her, than proficiency in classics or mathematics. Nature appears to have clearly assigned to the sexes distinctive mental, quite as much as physical characteristics, to have cast the intellectual powers of men and women not in the same mould, but rather in their counterparts; to have framed each with qualities imperfect by themselves, and only capable of becoming complete by being supplemented and modified by the opposite ones ; and it follows as a corollary that the faculties of each should be cultivated so as to supply the defects of the other—the one perfected in his hard matter of fact, logical and working pursuits—the other in the elegancies of life and literature.

Mr. Adams explained that he would by no means banish the emotional from a girl's training, but simply give a greater amount of time to the intellectual.

3. "The New Zealand *Anobiidæ*," by Captain T. Broun.

According to the author, this group possesses ten representatives in New Zealand, nine of which had been recently discovered by himself.

4. "Notes on a Salt Spring near Hokianga," by J. A. Pond. (*Transactions*, p. 512.)

5. Dr. Purchas then proceeded to exhibit a number of Telephones and Microphones, giving a full account of their construction and mode of action.

FIFTH MEETING. *7th October*, 1878.

T. Heale, President, in the chair.

New Member.—D. Hearn.

The Secretary read the list of donations to the Library and Museum since the last meeting.

The President informed the meeting that advices had been received of an intended presentation to the Museum of an extensive series of casts from the gems of antique sculpture, the donor being Mr. T. Russell, C.M.G. In order that this handsome gift may be rendered fully available, their townsman, Dr. Campbell, had liberally arranged to defray the expenses attendant on the establishment of a School of Design within the Museum Buildings. Dr. Campbell had also taken upon himself all expenses relative to the placing of the statuary in the Museum.

A vote of thanks to Mr. Russell and Dr. Campbell was unanimously agreed to.

1. "The *Dascillidæ* of New Zealand," by Captain T. Broun.

2. "Notice of the Occurrence of *Juncus tenuis*, Willd., in New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 433.)

Mr. Heale said that considering that the plant had been found in a remote portion of the Northern Wairoa, a district which had no foreign trade save with Australia, of which Mr. Cheeseman informed them *Juncus tenuis* was not a native, he should certainly be in favour of considering it truly indigenous.

3. "High Schools for Girls," by J. Adams, B.A.

In this paper the author endeavoured to lay down certain rules that should be adhered to in the establishment of girls' schools, and in the adoption of the curriculum for them.

Sixth Meeting. 18*th November*, 1878.

J. Adams, B.A., in the chair.

New Members.—W. Berry, J. M. Brigham, H. T. Pycroft, S. J. Williams.

1. On the *Telephoridæ* of New Zealand," by Captain T. Broun.

2. "Notice of the Occurrence of the Genus *Kyllinga* in New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 434.)

3. "Note on Traditional Changes of the Coast-line at the Manukau Heads," by S. Percy Smith. (*Transactions*, p. 514.)

4. "Notes on the Rising Generation," by D. C. Wilson.

ABSTRACT.

The author remarks on the small number of Maori children, and thinks that the Maori population is dying out. He gives a short description of their former mode of life, which he considers to have been better adapted to prolong life than their present semi-European habits. He thinks the only chance of preserving the Maori race is intermarriage with Europeans; and cites as a remarkable fact that when half-castes and Maoris intermarry, their offspring are numerous, and that even the smallest trace of European blood seems to have a good effect on the stamina of the children.

With regard to white children, he considers that the climate is in their favour, and that they will be perhaps an improvement on their fathers. He thinks that emigrants to the colony live longer than if they remained at home, and cites as an instance a community of Highland birth and descent,

who came to this colony *en masse* from North America, and now reside in the vicinity of Waipu and Whangarei, numbering with children about 1,000 souls. Out of this small population two have died at the age of 96, and in addition to a considerable number who reached various ages between 80 and 90, three have died within the present year at the ages of 90, 88, and 86. There are other five men and women with whom the author is well acquainted, now alive and in good health, at the ages of 92, 89, 87, 85, and 83. The number of those living and dead, who have reached fourscore, is also considerable; in fact, it is with them a common age, and calls forth but little comment.

ANNUAL GENERAL MEETING. 17*th February*, 1879.

R. C. Barstow in the chair.

New Members.—J. L. Bagnall, W. C. Breakell, C.E., W. Burton, A. D. L. Hammond, T. Lindesay, J. McColl, S. Vaile.

The Secretary read the minutes of the last annual meeting, held 18th February, 1878.

ANNUAL REPORT.

The Council of the Auckland Institute, in presenting their report for the past year, have again to congratulate the members on the steady progress made by the society, and on the increasing interest manifested by the public in its operations. Twenty-five new members have been elected during the year. The Council regret to have to record the death of five members. There have also been a few withdrawals, principally caused by removals to other parts of the colony. The total number on the register is now 281. Six meetings have been held during the winter session. The attendance on the whole was satisfactory, although there is room for improvement in this direction.

It is satisfactory to be able to state that the additions and donations to the Museum have been far greater than in any previous year. The Council have especial pleasure in drawing attention to the truly magnificent donation made by Mr. T. Russell, C.M.G., of a series of full-size plaster-casts from the most celebrated statues of antiquity. The importance of this gift can hardly be over-estimated; not only is it valuable from the beauty of the figures themselves, but more especially from affording to art-students an opportunity—hitherto entirely wanting—of studying and working from accurate copies of the unequalled productions of ancient Greece and Rome. The number of full-sized figures is twenty-two, of busts eleven. In addition to these, Mr. Russell has forwarded terra-cotta busts of the Prince and Princess of Wales, modelled by the well-known sculptor Count Gleichen. Mr. Russell's communications were, in the first instance, made through Dr. Campbell. This gentleman, well aware that the funds at the disposal of the Institute are little more than sufficient to meet current expenditure, most kindly offered to defray all expenses connected with the preparation of the pedestals and the unpacking of the casts and their erection in the Museum. Thanks to this timely and welcome liberality, the whole consignment has been placed in the Museum without any expense to the Institute.

It also occurred to Dr. Campbell that the advent of Mr. Russell's presentation might very well be taken advantage of to establish a school of design. He, therefore, addressed

the Council on the subject, offering, on his part, to provide a competent instructor and to bear all the expenses of the school if the Institute would grant the use of their lecture-room for the purpose. This proposal was accepted by the Council, and the school has now been in operation for some time. From twenty to thirty students have been in attendance, and the results promise to be in every way satisfactory.

A complete list of all additions to the Museum will be found appended, so that it will only be necessary to mention here those of special importance in the different classes.

1. *Mammalia.*—The only additions in this class are an interesting collection of bats, made by Mr. Parsons in the Friendly Islands, and some good specimens of *Ornithorhynchus* and a few Marsupials, presented by Mr. H. A. H. Monro.

2. *Birds.*—Four hundred and thirty-five skins have been received during the year. Of these about 200 are of New Zealand species, collected partly to supply deficiencies in the type collection, and partly for exchanges with foreign museums. From the Australian Museum, Sydney, 103 skins have been forwarded, principally of Australian species. A collection of 60 European species has also come to hand from the Geneva Museum. Mr. Parsons has presented 61 skins, all obtained on the island of Vavau, one of the Samoan Group. Under the head of Oology should be mentioned a series of European birds' eggs, forwarded in exchange by the Geneva Museum, and some of New Zealand species contributed by Mr. T. H. Potts, of Canterbury.

3. *Fishes and Reptiles.*—The most noteworthy addition is from Mr. Parsons, of Vavau, and is especially valuable, not only from the number of species, but also from the large number of duplicate specimens which will be useful for exchanges. The Institute is also indebted to Captain Fairchild, of the s.s. Hinemoa, for a number of Tuatara lizards *(Sphenodon)*, obtained on Karewa Island, near Tauranga.

4. *Invertebrata.*—The collection of New Zealand *Mollusca* in the Museum has been largely increased during the year, and a few small parcels of foreign species have also been received, principally from the Polynesian Islands. A series of Swiss *Coleoptera*, also of *Crustacea* from the south of Europe and the Mauritius, are among the exchanges received from the Geneva Museum. An excellent collection of butterflies from New Britain and New Ireland, forwarded by the society's old friend, the Rev. G. Brown, must also not be overlooked.

5. *Ethnology.*—A set of plaster casts of the heads of Polynesians of different races, taken from models obtained during the expedition of Dumont D'Urville, has been received from the Paris Museum of Natural History. From Mr. H. N. Rust, of Chicago, U.S., comes a very interesting collection, including crania of the Flat-head Indians, also of the ancient Mound-builders of the Mississippi Valley, with specimens of their peculiar pottery, stone adzes, flint arrow-heads, etc.

6. *Geology and Mineralogy.*—A type collection of 400 specimens of rocks, purchased in London from the well-known mineralogist, Mr. I. R. Gregory, has been received, but still remains unpacked, there being no cases available in which to place it. Several small contributions of New Zealand rocks and minerals have been made, but nothing calling for special mention.

New Fittings.—Additional accommodation for stuffed birds and mammals has been obtained by the erection of a large show-case along the south side of the Museum Hall. The cost—£106—has been liberally defrayed by a friend of the Institute, who, however, desires that his name should not be made public. About 300 birds and 30 mammals have been mounted and placed on exhibition during the year, but nearly all the skins received during the past twelve months still remain packed up in cases, the funds of the

Institute not being sufficient to keep a taxidermist continuously at work. The most urgent requirements in the Museum are now table cases, through the want of which the greater portion of the mineralogical collection has to be stowed away in boxes. A large show-case for the collection of New Zealand birds is much needed, as also fittings for packing away duplicates, specimens selected for exchanges, etc.

Library.—The Council have to acknowledge the receipt of a grant of £95, under the Public Libraries Subsidies Act. This amount has been expended in the purchase of standard scientific works, and the books are now on their way from London. The Provincial Library still continues under the care of the Institute, under the very unsatisfactory arrangement first made with the Government, as mentioned in the last report. The number of readers has been large, and is still increasing.

No action has been taken by the Government in reference to the endowment of the Museum. The Council very much regret that this is the case, for they cannot conceal the fact that the revenue of the Institute—always much too small for the proper fulfilment of its duties—does not increase in nearly the same proportion as the demands upon it. There can be no doubt that if Auckland is to possess a public museum and library worthy of the name, an assured and stable income must be granted for its support, and that in no case should either the museum or library depend entirely for its existence upon the precarious and fluctuating revenue derived from annual subscriptions. The Council trust that the Auckland members of Parliament will, during its next session, endeavour to obtain some permanent source of revenue for the institution.

The annual balance-sheet showed the receipts to be £525 17s. 2d. (including the balance of £74 16s. 8d. carried from last year's accounts). The expenditure amounted to £496 8s. 1d., leaving a balance of £29 9s. 1d.

Election of Officers for 1879:—*President*—Rev. A. G. Purchas, M.R.C.S.E.; *Council*—R. C. Barstow, Rev. J. Bates, J. L. Campbell, M.D., J. C. Firth, His Honour Mr. Justice Gillies, T. Heale, Hon. Col. Haultain, G. M. Mitford, J. Stewart, M. Inst. C.E., T. F. S. Tinne, F. Whitaker; *Auditor*—T. Macffarlane; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.

On the motion of Mr. Ewington, seconded by Col. Haultain, it was resolved—

"That the thanks of this meeting be accorded to those gentlemen, whose generosity to the Institute during the past year has enabled the Council to lay before it such a gratifying report."

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting. *7th March*, 1878.

Professor von Haast, F.R.S., President, in the chair.

The President read his opening address. (*Transactions*, p. 495.)

Second Meeting. *4th April*, 1878.

Professor von Haast, President, in the chair.

New Members.—G. L. Mellish, W. Kitson, A. Lean, N. K. Cherill, C. W. Adams.

1. "Further Observations on Banks Peninsula," by Professor von Haast, F.R.S. (*Transactions*, p. 495.)

2. "On the Rock Paintings in the Weka Pass," by A. Mackenzie Cameron, Interpreter of Oriental Languages to the Government of New South Wales; communicated by Professor J. von Haast, Ph.D., F.R.S. (*Transactions*, p. 154.)

3. "Remarks on Mr. Mackenzie Cameron's Theory respecting the Kahui Tipua," by J. W. Stack.

Third Meeting. *2nd May*, 1878.

The Rev. J. W. Stack, Vice-president, in the chair.

New Members.—Henry Sealy, H. M. Lund.

Fourth Meeting. *6th June*, 1878.

Professor von Haast, President, in the chair.

New Member.—J. Broham.

1. "On some *Coccidæ* in New Zealand," by W. M. Maskell. (*Transactions*, p. 187.)

Fifth Meeting. *4th July*, 1878.

Professor von Haast, President, in the chair.

New Member.—W. E. Ivey.

1. "On some *Coccidæ* in New Zealand" (second paper), by W. M. Maskell. (*Transactions*, p. 187.)

2. "On a Hymenopterous Insect parasitic on *Coccidæ,*" by W. M. Maskell. (*Transactions*, p. 228.)

3. "On Temporary and Variable Stars," by Prof. A. W. Bickerton, F.C.S., Associate of the Royal School of Mines, London. (*Transactions*, p. 118.)

Sixth Meeting. 1*st August*, 1878.

Professor von Haast, President, in the chair.

New Members.—G. Grey, G. Wilkinson, J. W. Bruce.

1. "On some *Coccidæ* in New Zealand" (third paper), by W. M. Maskell. (*Transactions*, p. 187.)

2. "Partial Impact: a possible Explanation of the Origin of the Solar System, Comets, and other Phenomena of the Universe," by Prof. A. W. Bickerton. (*Transactions*, p. 125.)

Seventh Meeting. 12*th September*, 1878.

Professor von Haast, President, in the chair.

New Members.—Dr. Doyle, Dr. Ellis, W. P. Cowlishaw, A. Reischik.

1. "On the Calculation of Distances by Means of Reciprocal Vertical Angles," by C. W. Adams. (*Transactions*, p. 132.)

Eighth Meeting. 3*rd October*, 1878.

Professor von Haast, President, in the chair.

New Members.—J. von Tunzleman, A. D. Dobson, G. McIntyre.

Annual General Meeting. 7*th November*, 1878.

Professor von Haast, President, in the chair.

Election of Officers for 1879 :—*President*—Professor Bickerton ; *Vice-presidents*—J. Inglis, R. W. Fereday ; *Council*—Rev. J. W. Stack, Professor Cook, Dr. Powell, Professor von Haast, Dr. Coward, G. W. Hall ; *Auditors*—W. D. Carruthers, C. R. Blakiston ; *Hon. Treasurer*—W. M. Maskell ; *Hon. Secretary*—J. S. Guthrie.

ABSTRACT OF ANNUAL REPORT.

The Council congratulate the Institute on the increase of their numbers, nineteen new members having joined during the session. The Council have had under their consideration the propriety of establishing monthly popular lectures in connection with the Institute, but were unable to make any arrangements for the past session. They, however, strongly urge upon their successors the desirableness of making some definite arrangements for such lectures during the next session.

The microscopical section has held thirteen meetings during the year, and the attendance has been most satisfactory. As this has been the first year's work of the section, it could hardly be expected that more than preliminary work could be done. A large number of preparations—nearly 200—have been exhibited at the meetings, and the members have been assiduous also in private work. The work of the different meetings has embraced marine and fresh-water *Algæ*, anatomical and botanical specimens, in great variety. Original research in entomology has been undertaken by one member, and four papers resulting therefrom have been read before the Institute.

The Council, feeling that one of the great aims of this Institute is the encouragement of Art, and the spread of its knowledge amongst the people of this district, have decided to obtain the principal publications of the Arundel Society.

The Treasurer's report shows a balance in hand of £136 2s. 7d.

1. "On *Desis robsoni*, a Marine Spider from Cape Campbell," by Llewellyn Powell, M.D. (*Transactions*, p. 263.)

OTAGO INSTITUTE.

First Meeting. *14th May*, 1878.

W. N. Blair, President, in the chair.

New Members.—Prof. Ulrich, J. H. Pope, A. Y. Smith, F. Howlett, Jno. Allan, J. D. Walker, J. Galloway.

1. Prof. Hutton exhibited specimens of *Graptolites fruticosus*, Hall, and (apparently) *G. gracilis*, Hall, from the Nelson District, which had been presented to the Museum by Prof. Ulrich. Both these species occur in lower silurian rocks in Australia and North America.

Prof. Hutton also exhibited a specimen of the rare six-wired Bird of Paradise (*Parotia sefilata*) from North New Guinea.

2. "On Antarctic Exploration," by C. W. Purnell. (*Transactions*, p. 31.)

3. "Notes on Cleistogamic Flowers of the Genus *Viola*," by Geo. M. Thomson. (*Transactions*, p. 415.)

Second Meeting. *28th May*, 1878.

W. Arthur, Vice-president, in the chair.

New Member.—M. H. Aikman-Gray.

Mr. Petrie, M.A., gave a lecture on "The Science of the Weather."

Third Meeting. *11th June*, 1878.

W. Arthur, Vice-president, in the chair.

New Members.—Maxwell Bury, P. G. Pryde.

1. "The Sea Anemones of New Zealand," by Prof. Hutton. (*Transactions*, p. 308.)

2. "On the Means of Fertilization among some New Zealand Orchids," by Geo. M. Thomson. (*Transactions*, p. 418.)

Fourth Meeting. *25th June*, 1878.

W. N. Blair, President, in the chair.

New Member.—A. Buechler.

Prof. Hutton gave a lecture on "The Fauna of New Zealand."

Fifth Meeting. *9th July*, 1878.

W. N. Blair, President, in the chair.

New Members.—Dr. Ferguson, F. Jeffcoat, junr., J. Morrison, R. Sparrow, J. Cormack.

1. "On the Brown Trout introduced into Otago," by W. Arthur, C.E., (*Transactions*, p. 271.)

Sixth Meeting. *15th July*, 1878.

W. N. Blair, President, in the chair.

The Hon. Robert Stout, Attorney-General, gave a lecture entitled "A Plea for the Study of Politics."

Seventh Meeting. *13th August*, 1878.

Prof. Hutton, Vice-president, in the chair.

New Members.—R. H. Leary, Wm. Taylor, J. Forsyth, Jas. Arkle.

1. "Our Fish Supply," by P. Thomson. (*Transactions*, p. 380.)

2. "A Description of inexpensive Apparatus for measuring the Angles of Position and Distances of Double Stars, and the Method of using it," by James H. Pope. (*Transactions*, p. 141.)

3. "New Zealand *Crustacea*, with Descriptions of new Species," by George M. Thomson. (*Transactions*, p. 230.)

4. "Descriptions of two new Crabs," by Prof. Hutton.

5. "Notes on the New Zealand Shells in the 'Voyage au Pôle Sud'," by Prof. Hutton.

Eighth Meeting. *10th September*, 1878.

W. Arthur, Vice-president, in the chair.

New Members.—R. Peattie, A. Herdman.

Prof. Hutton exhibited two eggs of the Nelly or Stink-pot (*Ossifraga gigantea*) from Macquarie Islands, which had been presented to the Museum by Mr. John Cormack.

1. "On a new Species of *Millepora* (*M. undulosa*), from Foveaux Strait," by the Rev. J. E. Tenison-Woods, of Sydney; communicated by Prof. Hutton. (*Transactions*, p. 345.)

2. "Notes on a Collection from the Auckland Islands and Campbell Island," by Prof. Hutton. (*Transactions*, p. 337.)

3. "On *Phalacrocorax carunculatus*, Gmelin," by Prof. Hutton. (*Transactions*, p. 332.)

4. "Description of a new Crustacean from the Auckland Islands," by George M. Thomson. (*Transactions*, p. 249.)

NINTH MEETING. *24th September*, 1878.

W. N. Blair, President, in the chair.

New Members.—C. H. Robson, A. Moritzson.

The Rev. A. R. Fitchett gave a lecture on "Domestic Æsthetics, and the Higher Education of Women."

TENTH MEETING. *8th October*, 1878.

Prof. Hutton, Vice-president, in the chair.

New Members.—Mrs. Edwards, Miss V. Edwards, W. G. Jenkins.

1. "On Magnetic Dip," by A. H. Ross.

ABSTRACT.

After describing the nature of magnetic dip and the circumstances that led to its discovery, the author proceeds to state that "the first magnetical observation taken on the shores of New Zealand of which I can find any record was taken by Captain Cook at Dusky Bay in May, 1773, one hundred and five years ago. He then found by three different needles the variation or declination to be 13° 49′ E., and the dip or inclination 70° 5′ 45″. The next observation, in the same place, was taken by Captain Stokes in 1851, the declination then being 15° 34′ E., and the inclination 69° 47′, the decrease in the angle of inclination having been 18′ 45″ in seventy-eight years. It is not at all improbable, however, that the inclination was increasing in 1773, and having attained its maximum at some period of which we have no record, had decreased to the amount observed by Captain Stokes in 1851.

"The inclination of the needle is also subject to diurnal variation, being in the morning of each day 4′ greater than in the afternoon; it also changes when the needle is elevated to considerable heights.

"I have made these few remarks in reference to the inclination with a view of compensating for the dryness of what is really my paper of to-night, and which consists solely of a tabulated statement of observations made by me during a recent voyage from England, chiefly with the object of ascertaining the position in reference to the geographical equator of the point in the magnetic equator over which our vessel passed, and which is shown to have been situated in latitude 8° 30′ S. and longitude 25° 30′ W. The observations were taken whenever practicable by means of an instrument specially constructed for the purpose by Mr. Casella, of London. At the commencement of the voyage, the case containing my instruments was

unfortunately by mistake placed in the hold, so that about a fortnight elapsed after starting before any observation could be taken. It was also impracticable, through stress of weather, to take observations for several consecutive days, during which the southern dip had increased from 35° to 56°."

Observations of the Dip of the Magnetic Needle, taken during Voyage from England to New Zealand.

North Lat.	Long.	Dip.	South Lat.	Long.	Dip.	South Lat.	Long. E.	Dip.
30° 19′	19° 41′ W.	63° 30′	21° 55′	30° 21′	19°	44° 26′	52° 30′	69°
27 15	21 30	62 30	26 24	32 38	20	44 16	54 02	69
23 50	—	60 30	30 35	31 34	23	44 25	57 23	70
20 46	23 56	57 00	33 32	27 55	30	44 22	63 25	70
18 46	25 32	55 00	34 28	22 46	31	44 23	68 30	70
15 33	25 43	51 00	34 37	20 22	34	44 20	74 07	70
14 50	25 48	49 30	36 22	16 22	35	43 58	79 17	69
10 42	25 00	32 0	39 24	0 28 W.	56	45 03	84 15	72
8 08	23 14	26 0	39 35	2 05 E.	55	44 18	107 40	80
6 15 40″	21 59	22 30	39 49	6 20	55	45 22	117 59	79
4 19	19 18	21 0	40 37	8 05	56	46 19	124 30	81
2 52	19 34	10 0	41 16	12 06	57	46 43	130 18	82
0 35	20 45	8 0	42 12	17 30	56	47 09	137 00	83
2 21 S.	22 47	6 0	42 26	22 30	58	46 52	143 30	82
6 02	24 58	2 N.	42 31	27 00	58	46 56	150 30	78
8 30	25 30	Nil	42 48	31 27	62	46 28	155 39	75
9 46	25 47	1 S.	43 48	36 41	64	45 17	158 48	72
13 13	27 33	5 0	42 50	39 03	69	45 10	160 30	73
15 10	27 46	9 0	41 48	40 36	66	47 12	164 12	77
16 16	27 42	10 0	42 29	44 18	68	48 30	167 30	80
18 22	28 19	17 0	43 00	48 00	68	—	—	—

2. "Notes on the Life History of *Charagia virescens*," by the Rev. C. H. Gossett; communicated by Prof. Hutton. (*Transactions*, p. 347.)

3. "Description of a new Species of *Coprosma*," by D. Petrie, M.A. (*Transactions*, p. 426.)

4. "List of the New Zealand *Cirripedia* in the Otago Museum," by Prof. Hutton. (*Transactions*, p. 328.)

5. "Notes on some New Zealand *Echinodermata*, with Descriptions of new Species," by Prof. Hutton. (*Transactions*, p. 305.)

6. "On a new Infusorian parasitic on *Patella argentea*," by Prof. Hutton. (*Transactions*, p. 330.)

Eleventh Meeting. *22nd October*, 1878.

W. Arthur, Vice-president, in the chair.

The Hon. Robert Stout, M.H.R., was chosen to vote in the election of the Board of Governors for the ensuing year in accordance with clause 7 of "The New Zealand Institute Act."

The nomination for the election of honorary members of the New Zealand Institute was made in accordance with Statute IV.

Prof. Scott gave a lecture on "The Mechanism of Voice and Speech."

TWELFTH MEETING. *26th November*, 1878.

W. N. Blair, President, in the chair.

1. "On the Scientific Form of Harbours," by W. G. Jenkins.

2. "Note accompanying Specimens of the Black Rat (*Mus rattus, L.*)," by Taylor White; communicated by Prof. Hutton. (*Transactions*, p. 343.)

3. "Descriptions of some new Slugs," by Prof. Hutton. (*Transactions*, p. 331.)

4. "Description of a new Species of Isopodous Crustacean (*Idotea*)," by George M. Thomson. (*Transactions*, p. 250.)

5. "On the New Zealand *Entomostraca*," by George M. Thomson. (*Transactions*, p. 251.)

ANNUAL GENERAL MEETING. *5th February*, 1879.

W. N. Blair, President, in the chair.

New Members.—T. B. Low, — Williams, of Shag Point.

The Report of the Council was read and adopted.

ANNUAL REPORT.

The Council has much pleasure in presenting its Annual Report to the members of this Institute, and in congratulating them on the progress made.

During the last session, thirteen General Meetings have been held. At five of these, lectures were delivered to large and appreciative audiences, and the Council would take this opportunity of recommending the continuance of these popular lectures, as tending to foster a more general interest in the success of the Institute. The other eight meetings were devoted to the reading of papers, and were fairly attended. At these, twenty-five papers were read by twelve authors, of whom two are resident in the North Island, and one in Sydney. This is the largest number of papers yet read in one year before the Institute, the numbers for 1875, 1876, and 1877 being respectively 15, 21, and 16. Of these papers, sixteen relate to Zoology, three to Botany, and six to Miscellaneous subjects.

Since the last Annual Meeting, 29 new members have joined the Institute. Against this addition, however, 41 names have been removed from the list, of members who have died, retired, or left the district, leaving a total membership of 212. One member has become a life-member.

The balance-sheet shows that the receipts for the year amounted to £264 2s. 11d. (including a balance from last year of £61 2s. 11d.), while the expenditure was £205 15s. 9d., leaving a balance in the Treasurer's hands of £58 7s. 2d. There is also a sum of £79 8s. 5d. in the Government Savings Bank to the credit of the Institute.

Election of Officers for 1879:—*President*—Prof. Hutton; *Vice-presidents*—W. N. Blair, C.E., Prof. Scott; *Council*—W. Arthur, C.E., Robert Gillies, F.L.S., Dr. Hocken, A. Montgomery, D. Petrie, J. C. Thomson, Prof. Ulrich; *Hon. Secretary*—Geo. M. Thomson; *Hon. Treasurer*—H. Skey; *Auditor*—J. S. Webb.

The retiring President read the following

ADDRESS.

It has become the custom for the retiring President to address you on the work of the session, the aims and prospects of the Institute, or the prominent scientific topics of the day. I cannot do better than follow in the same strain, but instead of confining myself to one of these subjects, I shall glance shortly at all of them in succession. So far as the last head is concerned, anything of a general character that I can say on current scientific questions must be second-hand. You can get it in a more attractive form in the thousand-and-one addresses and articles that flow annually from the scientific press throughout the world. I shall therefore only consider it in so far as it applies to the material progress of the colony.

The Otago Institute has now entered on the tenth year of its existence. Its career can scarcely be characterized as brilliant; it has not brought to light wonderful discoveries in science, nor propounded strange doctrines in philosophy; still its progress has been steady, and it has done useful work in promoting the cause of science and the general well-being of the state.

The work during the last session has been up to the average of previous years. Twenty-five papers were read at the ordinary meetings, and five lectures were delivered at what are called the popular meetings. Of the twenty-five papers nineteen were on subjects of Natural History, nine of them having been contributed by Professor Hutton, and six by Mr. G. M. Thomson. Those of us who heard these papers read or commented on, could not help being struck by the scientific skill and care displayed by their authors, in investigating the subjects under consideration, and the exactness with which every minutia of form and organism was delineated and described. I have no doubt many of the facts thus recorded will be highly prized by the scientists of the old world. Specialists here and there will perchance find among them the clue to some great truth that otherwise might never be revealed.

The five remaining papers were on miscellaneous subjects. My absence from Dunedin prevented me hearing the two relating to Navigation by Messrs. Pope and Ross but I understand they formed a valuable contribution to the literature of Nautical Science.

Mr. Purnell's paper on Antarctic Exploration opens up a world of speculation as to the direction in which the adventurous spirit of the New Zealander of the future will find an outlet. Doubtless the discovery of the South Pole will some day become as much an object of ambition to the Briton of the South as the North Pole now is to his elder brother.

Two interesting and valuable papers on kindred subjects—acclimatized and native fish—were read by Messrs. Arthur and Thomson; the former described the steps that have from time to time been taken to stock the Otago streams with brown trout and the success that has been achieved. We trust that Mr. Arthur will supplement his contribution of this year by a similar treatise on the other acclimatized wild animals. Mr. Thomson's labours, in having for three successive years taken a daily note of the varieties of fish in

the market, in order to determine when each kind is in season, deserve great praise. What are now wanted are similar observations in Wellington and Auckland. A comparison of the results at the three places would give data from which could be deduced a tolerably correct idea of the habits and peculiarities of the common native fishes.

The last of the miscellaneous papers is by Mr. Jenkins, on the scientific form of harbours. Although some of the conclusions may not be considered orthodox from an engineering point of view, it contains much valuable information on a subject of popular interest, consequently the paper is well deserving of a place among our records.

The five public lectures given on the alternate fortnights during the session were well attended. They are useful adjuncts to our means of disseminating information, and tend to popularize the Institute. The lectures were all of a high class, interesting and instructive, and elevating in tone and character. The gentlemen who delivered them have earned our best thanks for the trouble they took in the matter.

In looking back on the career of the Otago Institute, I am interested in comparing its actual work with what I expected from it. Although I had no immediate share in establishing the Institute, I claim to have at an early date suggested its formation. In September, 1866, a year before the New Zealand Institute Act was passed, and three years before the Otago branch was established, the "Daily Times" published a letter of mine on the subject. This letter defined what I considered should be the objects of such an association in a new country, and the means by which they were likely to be attained. Briefly the objects were to be:—The investigation of the natural resources of the country from an industrial point of view, and their fitness to our everyday wants; the development of manufactures; the encouragement of the construction of labour-saving machinery; and the consideration of engineering works generally, in their application to the requirements of the country.

The means suggested for attaining these objects were what are now followed in the papers, discussions and Transactions of the Institute, together with the establishment of an Industrial Museum.

Thirteen years have passed away since the above ideas were crudely expressed, but they have brought no material change in my opinions. As shown by Sir George Bowen, in his opening address to the parent society in Wellington in 1868, I hold that the principal object in the establishment of the New Zealand Institute is to facilitate the practical work of colonization.

I do not for one moment deprecate the efforts of those who devote all their energies to the investigation of purely scientific subjects; New Zealand, from its geographical position at the extreme end of the habitable globe, its peculiarities in Natural History, and its newness in almost every sense, will long remain an object of the greatest interest to scientific men. What I regret is that practical science should occupy far less of our deliberations than its theoretical *confrere*, whereas their positions should, in my opinion, be reversed. I would not, however, like to see the number of scientific men reduced. What is wanted is, that a somewhat more practical bias should be given to their studies—a great increase in the number of workers in applied science, and increased enthusiasm amongst the few that do exist. If half the energy that is sometimes displayed in considering the microscopic distinction between two species of animalcules was only applied to the investigation of our mineral resources, the result would be an incalculable benefit to the whole community.

The present state of things is probably caused by the fact that the prizes in the arena of pure science are greater than in the more practical field. A comparatively unimportant

discovery at once brings the theoretical searcher into communication with the whole world of science, but the practical worker may spend a lifetime in developing the resources of the country and promoting the interests of his fellow-colonists, without being known or recognized outside the narrow sphere of his labours.

Instead of occupying his time in the study of abstruse theories which may well be left to the master minds of the old world, I think the labours of our scientific men of all kinds should be confined to the recording of observed facts in pure science, and the fuller investigation of such subjects as have a direct bearing on the practical work of colonization. Instead of speculating on the causes of earthquakes, the oscillations of land and sea, and the age of the moa, geologists, if they do not actually search for our minerals themselves, should at least define the age, extent and direction of the various geological formations, so as to indicate the localities in which minerals are likely to be found. Instead of investigating the peculiarities of some minute lichen found only on Mount Cook or Mount Egmont, our botanists should first exhaust the study of the forest trees, their rate of growth, general habits, and facility of reproduction.

We might in this way run round the "circle of the sciences," giving the positive and negative duties in each case, but it will be better if I simply refer to what has already been done in the cause of industrial science throughout the colony and what remains to be done within the jurisdiction of our Institute.

The New Zealand Exhibition of 1865 was the first and only systematic attempt made to investigate our resources. Considering it was collated at such an early stage of our history, and in a comparatively short time, the information contained in the jurors' reports is wonderfully complete and correct. The collection of 1865 has never undergone a general revision. Several of the subjects have been taken up individually by subsequent observers and the information amplified, but the results are diffused through so many varied publications, and so mixed up with extraneous matter, that they are scarcely available. To this day the reports, as they originally stood, form the only compendium we have of the resources and industries of the colony. Nearly all the important additions that have lately been made to our information on these subjects have been contributed by the Native Industry Committee of Parliament, and by Dr. Hector, Professor Hutton, Mr. Kirk, and the staff of the Colonial Museum; there are few amateurs in the field of practical science.

The principal subjects that have received special attention are:—Deposits of gold and coal; conservation of forests; qualities of soils; properties of native grasses; edible fishes; cultivation of *Phormium*, together with a few others of less importance. Dr. Hector's assistants—Messrs. Skey and Buchanan—have each in his own department done great service to the cause of science, theoretically and practically. Mr. Skey's original researches in the chemistry of our native products deserve more than the passing notice I can give. Each successive volume of the Transactions bears testimony to his untiring application.

What is now wanted is that the information already obtained on each subject should be collected and arranged in a systematic form, so as to be readily available to all. Blanks should be filled up where possible, and when this cannot be done, their existence should be pointed out, so that future observers may explore new ground.

In Geology much yet remains to be done; the Government geologists throughout the colony have accomplished as much as could reasonably be expected of them in the time, and with the means at their disposal. But it amounts to little more than a general indication of the *locale* of the different formations; the details of strike, inclination,

faults, mineral veins, and the hundred other particulars that constitute a complete survey are still wanting. It will be many years before the State can supply them. Why should the work not be done, to a great extent, by amateurs, for its own sake? It seems to me as interesting as fern-hunting, or the other botanical pursuits that are so popular. There are few districts in New Zealand that present greater inducements to geological research than the one immediately surrounding Dunedin. Every square mile speaks a volume, still there is not one page written. It is difficult to enumerate specifically the subjects in economic geology, about which information is most wanted, as there are so few about which our knowledge is in any way complete. Professors Hutton and Ulrich have given a concise summary of the present information in the "Geology of Otago," but it is mainly useful in showing that the field is practically unexplored.

The labours of Dr. Hector, Mr. Kirk, Capt. Campbell Walker and Mr. Buchanan, have thrown great light on economic botany so far as *Phormium*, timber-trees, and grasses are concerned, but the subject is by no means exhausted. We are still in the dark as to the habits, age, growth, habitat in relation to soil, elevation and climate, reproduction and cultivation, and numerous other particulars regarding the useful plants of the colony.

The chemistry of our native products is perhaps less known than any other of their attributes. As already stated, Mr. Skey's incessant labours have determined the constituents and properties of many of them, and Professor Black has also done good service in the same direction. But the field is so extensive, and the labourers are so few, that we can only consider the study as begun. The work already done bears about the same proportion to what is required as the meridian lines do to the other markings on a map. We want to ascertain the constituents of almost every product of the three natural kingdoms before they are utilized. It is chemists that tell us if our ores are payable; if our soils are productive; if our building stones are durable; if our mortars are tenacious; and if our food is wholesome. Without the information they can furnish, our material progress would be slow indeed, a mere groping in the dark.

In addition to the service he can render in analysing raw materials, the chemist in a new country has a wider field for original research than his compeer at home. He has before him every day substances to which chemical tests have never been applied, consequently his chances of being a discoverer are greatly increased. This alone should be an incentive to perseverance in every student of chemistry.

The publication in a systematic form of the analyses of native products, made at the various laboratories throughout the colony, would be a great boon to all who are interested in the promotion of applied science.

Turning now from natural science to the sciences that affect our interests as communities, we have numerous subjects worthy of a place in our deliberations. For instance, the sanitary condition of our towns; water supply; drainage and cleanliness in general. Intercommunication—postal, telegraph—and by means of roads, railways and steamers; the construction of harbours, and devastation by flood. All of these subjects are of vital importance to the community, and their consideration comes fairly within the functions of the Institute, still they are seldom discussed.

The development of manufactures is one of the most important, intricate and uncertain of the many subjects with which a new country has to deal; so much is it dependent on Free Trade and the other considerations of political economy. The all-important question "will it pay" comes in at every step, and each case is influenced by surrounding circumstance, consequently it must be settled on its merits. No general rule can be laid down on the subject. For these reasons the question of establishing manufactures is

one that can legitimately be discussed by the Institute. Many of the failures that have taken place might have been averted and thousands of pounds saved, had the matters been fully investigated beforehand; for example, the Taranaki iron-sand. It is well-known among scientific and practical men that, although repeatedly tried in other places, these sands have never been profitably reduced to metal in large quantities. If the existence of this fact had been generally known throughout New Zealand, the chances are that the great Taranaki experiment had not been made—an experiment that has caused much heart-burning and loss to the shareholders of the company, and brought discredit on the whole colony in the eyes of the scientific world.

There are negative benefits that would be conferred by the discussion of questions relating to manufactures. On the other hand such discussions would confer positive benefits on the community by indicating the channels into which these industries could be turned. There are many articles of manufacture which could be profitably produced in New Zealand with native materials, now lying dormant, and nothing but a full knowledge of the case is wanted to establish the trade.

To summarize the position, a wide and intelligent investigation and discussion of the question, such as an Institute of this kind should be capable of bestowing on it, is sufficient to make or mar any scheme of colonial manufacture that is proposed.

In connection with this part of the subject, I am often struck by the comparison between my ideas of manufactures in 1866, already referred to, and what the realization is in 1879. I then talked of, as in the future—manufactures to produce the necessaries of life—" flour, beer, leather, and woollen goods." We have long passed that stage; we produce more of them than we can consume, consequently they are becoming articles of export. If our progress in this direction for the next thirteen years is in proportion to the past, the question of manufactures will become of vital interest to the colony at large.

One of the most powerful aids in the development of our resources, and their utilization in the arts, is the establishment of an Industrial Museum in Dunedin. The one we have is practically a Natural History Museum. As such it is an invaluable and necessary adjunct to the machinery of the University; consequently the one I suggest does not come into competition with it, their objects being quite distinct. An Industrial Museum in New Zealand should constitute a complete compendium of our information on the economic resources and manufacturing progress of the colony, inscribed not only in written records, but in a systematic arrangement of specimens and samples of all kinds and from every locality; and in order to facilitate comparison, each class should be accompanied by types from other countries.

In addition to the information usually given, such as analysis, weight, strength, and other inherent properties, the extent of supply and cost of production, as compared with the imported type, should be shown on each article.

An objection may be raised to such a museum on the ground that it might degenerate into an advertising medium. Possibly it would be used by producers and manufacturers as such, but that is a minor evil. While the community is benefited to however small an extent, the question of personal profit may be disregarded. And if we analyse critically the moving power in the great exhibitions of all nations in older countries, it will be found that advertising and individual preferment generally are the main springs in those grand machines whose pulsations vibrate through every artery in the industrial world.

In addition to raw materials and ordinary manufactures, the museum would contain models and drawings of mines, machinery, and engineering works.

One great drawback hitherto to the establishment of an Industrial Museum in Dunedin was the want of a director, but that want has lately been supplied in Professor

Ulrich. I have no doubt the seed will now be planted, and his skilful care and guidance will train it into a goodly tree whose fruit is knowledge and wealth to the community at large.

I have taken up so much of your time in the consideration of the two first heads of my subject that a passing reference only can be made to the last—the state of applied science in the colony. It might have been interesting to trace our material progress in intercommunication within the last few years, the facilities that now exist for the exchange not only of commodities, but of ideas, as compared with what they were when the Institute was founded. And to speculate as to what the future will bring forth. The astounding discoveries made every day in practical electricity alone are sufficient to enlarge our expectations to the verge of the impossible. Already the heavenly bodies are rivalled in the brilliancy of artificial light, and I believe the day is not far distant when man can convey his thoughts to his fellows through a thousand miles of ocean without the intervention of his senses by the mere force of volition conveyed along the electric wire, or perchance even without that medium.

In conclusion, I would impress on all the members of the Otago Institute the desirability of observing and recording whatsoever may seem to them new facts, no matter how trivial they appear. Considering the opportunities we enjoy as residents in a new country we are woefully remiss in this duty, and no class is so culpable as my own professional brethren—engineers and surveyors. Much of this apathy is probably due to a want of confidence in our own knowledge or judgment. The amateur is afraid of appearing ignorant in the eyes of the expert. What he considers new and unique may turn out to be old and commonplace. In the old world, where every path of scientific knowledge is trodden bare by ages of research, such a danger exists, but it is not the case here. All the recorded observations on any particular subject can be mastered in a few days, so the remainder of the field is equally free and open to all comers.

By exercising their observant faculties to a moderate extent, embracing the opportunities they have of observing and afterwards recording the result in a systematic manner, the members of the Otago Institute would gain credit to themselves, and confer an inestimable benefit on all their fellow-colonists.

HAWKE BAY PHILOSOPHICAL INSTITUTE.

First Meeting, *13th May*, 1878.

S. Locke in the chair.

1. "A Memorandum of my First Journey to the Ruahine Mountain Range, and of the Flora of that Region" (Part I.), by W. Colenso, F.L.S.

Annual General Meeting, *3rd June*, 1878.

J. G. Kinross in the chair.

New Members.—The Right Rev. the Bishop of Waiapu, Dr. Wood, Dr. De Lisle, Mr. W. J. Miller, Mr. J. W. Thomson.

Election of Officers for 1878–9 :—*President*—The Hon. J. D. Ormond, M.H.R. ; *Vice-president*—The Right Rev. the Bishop of Waiapu ; *Council*—Messrs. Colenso, Kinross, Locke, Miller, Smith, Spencer, and Sturm ; *Hon. Secretary and Treasurer*—W. Colenso ; *Auditor*—T. K. Newton.

Resolved—That for the future the annual meeting shall be held in February instead of June.

ABSTRACT OF ANNUAL REPORT.

During the past year three ordinary meetings have been held, at which five papers by members were read.

Of the sixty-nine members whose names were printed in our last year's report, one has since died (our former esteemed vice-president, the late Bishop of Waiapu, Dr. Williams, whose death the Council regrets to have to record) and five have removed from Hawke Bay, leaving sixty-three on the roll. To these will have to be added the names of five new members lately admitted, making a present total of sixty-eight.

The books for the library, mentioned in last year's report, were duly sent out per 'Queen Bee,' which ship, however, was totally lost in Cook Strait. Those books were insured, and were re-ordered, and have subsequently been received here. An additional lot, to the amount of £65, has also been selected and ordered by the Council.

During the past year a few desirable objects and botanical specimens have been collected by a few members for the Museum.

The statement of accounts shows a balance of £120 15s. 5d. to the credit of the Institute, besides the sum of £100 placed in the Bank of New Zealand as a fixed deposit.

Second Meeting. *10th June*, 1878.

The Right Rev. the Bishop of Waiapu, Vice-president, in the chair.

1. "Notes on the Metamorphosis of one of our largest Moths, *Dasypodia selenophora*," by W. Colenso, F.L.S. (*Transactions*, p. 300.)

The reared moth was also shown.

2. "On the Moa (*Dinornis*, sp.)," by W. Colenso, F.L.S.

This was part I. of the author's paper on that extinct genus, comprising (1) the original paper written by him in 1841–42, and published in "The Tasmanian Journal of Natural Science," Vol. II., and (2) illustrative notes.

Several very fine specimens of Bones of the Moa from Poverty Bay, in excellent preservation, were also exhibited, and a considerable discussion followed.

THIRD MEETING. *8th July*, 1878.

Owing to the severity of the weather, very few members were present, and so the meeting was adjourned for a week.

FOURTH MEETING. *15th July*, 1878.

There being but a very few members present no papers were read; but new Scientific Books, Plates, and Specimens were examined.

FIFTH MEETING. *12th August*, 1878.

T. K. Newton in the chair.

1. "Notes on the Genus *Callorhynchus*, with a Description of an undescribed New Zealand Species," by W. Colenso, F.L.S. (*Transactions*, p. 298.)

2. "Contributions towards a better Knowledge of the Maori Race," by W. Colenso, F.L.S. (*Transactions*, p. 77.)

This paper was illustrated by many ancient Maori specimens; and by the plates in Cook's Voyages (original 4to edition), by plates in Parkinson's Journal, and also by sketches taken by Mr. Colenso when travelling on the East Coast of the North Island in 1837-38.

SIXTH MEETING. *9th September*, 1878.

S. Carnell in the chair.

1. "On the beneficial Raising of Trees suited for Timber and Firewood," by F. W. C. Sturm.

I beg to make a few remarks on the production of a most necessary article of daily want, that is, Firewood and Timber, both of which this part of New Zealand at least will feel the want of in a few years, as our indigenous forests, such as are easily approachable, are rapidly disappearing. It is therefore necessary that provision should be made to guard against such a want; it is of course the duty of a Government, or those to whom the management of a State is entrusted, to provide not only for the present, but likewise for future generations' wants. It may be no easy task for the present Government to find blocks of land suitable, and of easy access, near the centres of population for such purposes, as nearly all, if not all the land in such localities is in the possession of private parties; if, therefore, our large land-owners would assist the Government, and set aside a few

acres for forest plantations on their lands, it would greatly enhance the value of their estates, and benefit both the present and a future generation. The expense of planting a few acres would not be great, and the benefit thereof would no doubt be very remunerative.

I will now point out a few varieties of such trees as are of rapid growth, and suitable for this part of the country, I will say from the sea coast to the foot of our mountain ranges, both North and South, from Napier (on hills), either under grass or slightly covered with fern,—the various sorts of pines, of which the seed could be sown where they should remain, without transplanting, such as *Pinus austriaca*, or Austrian pine, *Pinus halepensis*, Aleppo pine, *P. maritima, P. lariceo, pinea, jeffreyi, insignis, sabiniana, torreyana*, and *ponderosa*; various sorts of Gums, as *Eucalyptus globulus* or Tasmanian Blue Gum, Stringy Bark, etc., *Robinia pseudo-acacia* (the thorny acacia), a tree of rapid growth; the timber is very strong and durable, particularly suited for fencing-posts. Of the following varieties the seeds should be sown in nursery beds, and when one or two years old, transplanted; this would be more expensive than when the seed can be sown where the trees are to remain, but as these are of slow growth for the first year or two, the labour of keeping them clear of weeds in open plantations would be too expensive. The following would be suitable, and are of rapid growth after the first two years:—*Abies douglasii, menziesii*, and *excelsa*, Californian and European Spruce, *Larix* or Larch Pine, Ash, and Mountain Ash. The seeds of all those mentioned are cheap and easily obtainable. Cuttings of the Elm, Plane, and Poplar, which grow very freely, should be planted. The Alder, *Almus glutinosa*, is likewise of rapid growth and makes good timber, and is particularly suited for wet or swampy grounds. A mixed plantation of the various trees mentioned would yield a good return in twenty or twenty-five years.

I will now give the size and age of a few varieties of some trees in my grounds near Clive. All the trees are measured two feet above the surface of the ground, the seeds of all were sown by myself; dates taken from my diary.

Thuja knightii, 30 inches in circumference, or 10 inches in diameter; about 20 feet high; age, 8 years and 11 months.

Cupressus macrocarpa, 63 inches in circumference, or 21 inches in diameter; about 30 feet high; 10 years old.

Pinus maritima, 37 inches in circumference, or 12 inches in diameter; 26 feet high; 7 years old.

Pinus austriaca, 33 inches in circumference, or 11 inches in diameter; 18 feet high; 7 years old.

Pinus insignis, 46 inches in circumference, or 15 inches in diameter; about 40 feet high; 8 years and 11 months old.

Cryptomeria japonica, 29 inches in circumference, or 9 inches in diameter; 24 feet high; 7 years old.

Wellingtonia gigantea, 30 feet in circumference, or 10 inches in diameter; 16 feet high; 4 years old.

Eucalyptus globulus, Blue Gum, 3 feet 10 inches in circumference, or 1 foot 3 inches in diameter; about 60 feet high; 6 years old.

Platanus orientalis, Plane, 21 inches in circumference, or 7 inches in diameter; 3 years 10 months old.

Poplus dilatata, or Lombardy Poplar, 3 feet 7 inches in circumference, or 1 foot 2 inches in diameter; about 50 feet high; 9 years old.

The last two sorts were grown out of cuttings. In the measurement of the various trees I have omitted fractions.

2. "On the Ignorance of the Ancient New Zealanders of the Use of Projectile Weapons," by W. Colenso, F.L.S. (*Transactions*, p. 106.)

Mr. Sturm remarked that he personally knew of the first introduction in (the East Coast of) New Zealand of the very toy-arrow described by Mr. C. Phillips in his paper, which took place at Poverty Bay in 1850, where Mr. Sturm was then (and for some time previous) a resident. In that year a young man, "who had been a great voyager and traveller, and who spoke several languages," joined Captain Harris' whaling station party in Poverty Bay, and *he* first made there this toy-arrow for the Maori lads, and taught them its use—as a plaything. The idle Maoris took to the novelty (as they mostly do) and made many. Mr. Sturm had not yet seen Mr. Phillips' description of the toy-arrow, but fully described the same and its manner of use, offering, indeed, to make some of them, and his whole account closely agreed with the description given by Mr. Phillips, with one exception, that Mr. Sturm never knew of any *set mark* having been struck by it.

3. "Further Notes* on *Danais berenice*." In a letter from Mr. F. W. C. Sturm to the Honorary Secretary, Hawke Bay Philosophical Institute. (*Transactions*, p. 305.)

SEVENTH MEETING. 14*th October*, 1878.

The Right Rev. the Bishop of Waiapu, Vice-president, in the chair.

1. "Memoranda of a Journey in which he succeeded in crossing the Ruahine Mountain Range, with Notes on the local Botany and Topography of that District," (Part II.) by W. Colenso, F.L.S.

At the close, Dr. Spencer proposed, and Mr. J. A. Smith seconded, a unanimous vote of thanks to Mr. Colenso for his very interesting paper, which was also earnestly supported by the Right Rev. Chairman, and warmly accorded by the meeting, with a further particular wish, that the same should be recorded.

2. "On certain New Zealand and Australian Barks useful for Tanning Purposes," by J. A. Smith.

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* See Trans. N.Z.I., Vol. X., p. 276.

With regard to tanning barks in New Zealand, I beg to remark on the indigenous trees, and also the imported, the cultivation of which would prove highly remunerative, a desirable industry for the Colony, and a good export.

The native trees which contain tannin are (1) the Tawero, synonymous with Towai (*Weinmannia racemosa*, Forst). (2) Whinau, (3) Toatoa, (4) Tawai, (5) Makomako, Yellow Kowai, and others.

The tannin in our New Zealand Trees certainly does not abound, but it is amply made up for by the introduction of the numerous varieties of the *Acacia* from Australia.

The whole tribe of *Acacia* medicinally contains a valuable astringent, consequently tannin more or less in the various species of which now more than 300 sorts are known to science. Those of which the bark for tanning is used in Australia are but few sorts, such as are large growing trees, and of easy access. The undermentioned are commonly used in different parts of Australia and New Zealand, and exported in considerable quantities to England :—

The first is generally known as the Silver Wattle (*dealbata*), now so plentiful in the North Island; also the *falcata*, the *melanoxylon*, or blackwood, and the *mollissima*, woolly-leaved. All these are to be seen in Napier gardens.

I am informed that in Victoria, the Silver Wattle seed is sown there as a speculation; that in three years the trees are worth £5 per acre—the bark for tanning purposes, the wood for fuel. The great advantages of these trees is, that when the seed is once sown, it does not require renewal, as it is supplied in the future by suckers from the roots and falling seed.

The value of *Acacia* bark for tanning purposes in New Zealand is about £8 per ton.

If these trees were planted along our railway lines where they are fenced, it would no doubt be a large source of revenue, and amply repay the outlay; they would also prove shelter from the sun, the wind, and the dust. The *Acacia* has already been tried with advantage in Algeria, and the Home authorities intend cultivating it in the island of Cyprus.

Mr. Colenso related the *first* use of the barks of New Zealand trees for tanning purposes, which took place at Ngunguru (between Whangarei and the Bay of Islands), in the years 1839, 1840, and 1841, which had come under his special notice while living at the Bay of Islands, and often travelling in that district. This was the *first* place in New Zealand where hides were tanned for leather, the whole process was particularly primitive. Extracts of those several barks there used, with specimens of the trees producing them, he had sent to Sir W. J. Hooker, the Director of the Royal Gardens at Kew, long before New Zealand became a British Colony.

3. "A Description of two New Zealand Ferns, believed to be new to Science (*Cyathea polyneuron*, and *Hymenophyllum erecto-alatum*)," by W. Colenso, F.L.S. (*Transactions*, p. 429.)

4. Several novel and curious specimens, both Zoological and Botanical, and all indigenous, were then shown by Mr. Colenso, and minutely examined. Among them were (1) the peculiar long flat aquatic worms (*Gordius aquaticus*, Gml.), obtained from the waters of the "Forty-Mile Bush," which, when living, were very elastic; collected by Mr. Thomson. (2) A small sea-fish, *C. sprattus*, var. *antipodarum*, Hector, ("Edible Fishes of New Zealand," p. 133), obtained on the south shore of Hawke Bay, at a time when they were observed to be in large shoals; collected by Mr. W. J. Miller. (3) A Marine Spider, from the Bay of Islands, captured by the exhibitor (Mr. Colenso) in 1836, in deep water, and believed to differ from the one recorded at p. 299, Transactions, Vol. X. (4) Specimens of several elegant Ferns, among them were those of the two new ones (*C. polyneuron* and *H. erecto-alatum*) to illustrate the paper read.

Council Meeting. 22*nd November.*

The Hon. J. D. Ormond, M.H.R., President, in the chair.

New Members.—Miss J. Herbert, Sir Thomas Tancred, Bart., Rev. F. E. T. Simcox, E. H. Bold, H. Campbell, W. Heslop.

The Hon. W. B. D. Mantell, F.G.S., of Wellington, was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

The nomination for the election of an honorary member of the New Zealand Institute was made in accordance with Statute IV.

WESTLAND INSTITUTE.

FIRST MEETING. *16th July*, 1878.

R. C. Reid, Vice-president, in the chair.

1. "On Beach Protection," by W. D. Campbell, F.G.S., Assoc. Inst. C.E. (*Transactions*, p. 146.)

This paper was accompanied by diagrams.

2. "Notice of a Tadpole found in a Drain in Hokitika," by F. E. Clarke.

The embryo amphibian was found in a small pool of water left in the bottom of the drain, after being cleared of rubbish, etc., by the Corporation labourers.

It had suffered considerable injury, either from being trodden on or from being cut by the shovel of the labourer, its bowels protruding through the wound. Although alive when captured, this soon caused its death.

From its appearance, it would be about three weeks old, the lungs and hind-legs being well developed, but the fore-legs were merely rudimentary. From its size it seemed to be the tadpole of a very large frog.

No frogs or frog-spawn having been introduced nearer to the West Coast of New Zealand than Nelson or Christchurch (in both of which places, I understand, the "musical amphibians" are rapidly increasing), it is puzzling to conjecture in what manner the little stranger arrived in a territory having a climate so thoroughly congenial to its kith and kin.

No others have been discovered since, although the drains and creeks have been many times carefully examined.

Total length, 2·3 inches; length, from head to hind legs, ·85 inches; diameter of eye, ·1 inch; width of mouth, ·15 inch.

3. "On some new Fishes," by F. E. Clarke. (*Transactions*, p. 291.)

This paper was accompanied by drawings of the fishes described.

4. "The District of Okarita, Westland," by A. Hamilton. (*Transactions*, p. 386.)

Mr. Clarke stated that moa bones had been found in several places in Westland, and in one instance in large quantities.

SECOND MEETING. *8th January*, 1879.

His Honour Judge Weston, President, in the chair.

1. "On a new Fish," by W. D. Campbell, C.E., F.G.S. (*Transactions*, p. 297.)

2. "On a new Fish found at Hokitika," by F. E. Clarke. (*Transactions*, p. 295.)

3. Mr. W. D. Campbell gave a short account of the discovery of moa bones near Marsden.

Annual General Meeting. *13th December*, 1878.

R. C. Reid, Vice-president, in the chair.

Election of Officers for 1879.—*President*—His Honour Judge Weston *Vice-president*—R. C. Reid; *Committee*—Dr. James, Dr. Giles, James Pearson, R. W. Wade, E. B. Dixon, John Nicholson, H. L. Robinson, D. McDonald, W. D. Campbell, Robert Walker, A. H. King, T. O. W. Croft *Treasurer*—W. A. Spence; *Secretary*—John Anderson.

ABSTRACT OF ANNUAL REPORT.

The Committee held eleven ordinary and three special meetings during the year.

Nearly 200 volumes of standard works have been added to the library, and the Committee acknowledge numerous donations to the library and museum.

At the last annual meeting the liabilities amounted to £74 7s. 2d.; now, however, a small credit balance is shown. Among the receipts was a sum of £96, being part of the sum voted by Parliament for public libraries.

NEW ZEALAND INSTITUTE.

NEW ZEALAND INSTITUTE.

TENTH ANNUAL REPORT, 1877-78.

Meetings of the Board have been held during the past year on 29th of August, and 8th September, 1877; and 2nd January, 29th of May, and 28th June, 1878.

In accordance with the Act, the following members retired from the Board:—Mr. W. T. L. Travers, the Hon. Mr. Waterhouse and the Hon. Mr. Stafford. The two former gentlemen were re-appointed, and Mr. Thomas Mason was appointed in the room of the Hon. Mr. Stafford.

In compliance with clause 7 of the Act, the Incorporated Societies elected the following gentlemen as Governors of the Institute:—Mr. J. C. Crawford, F.G.S., Mr. Thomas Kirk, F.L.S., and the Bishop of Nelson.

The honorary members elected under Statute IV. of the rules of the Institute, are:—His Excellency Governor F. A. Weld, C.M.G., Tasmania; Professor Spencer Baird, U.S.A.; and Dr. D. Sharp, Scotland.

The following is a list of members now on the roll of the Institute, showing an increase of 113 during the past year:—

Honorary Members	27
Ordinary Members:	
Auckland Institute	278
Hawke Bay Philosophical Institute	68
Wellington Philosophical Society	222
Nelson Association	50
Westland Institute	175
Canterbury Philosophical Institute...	99
Otago Institute	224
Total	1,143

Volume X. is now being issued to members, and also to the various Libraries, Societies, and persons mentioned in the list appended.

The publication of the volume was commenced on the 2nd January, and the first copies were received from the publisher towards the end of May.

The large accession of members to the affiliated Societies, not having been notified to the Manager at a sufficiently early date, the number of copies of Volume X. was not increased, so that the edition will be at once exhausted, and no spare copies of this volume will remain on hand.

Volume X. contains 78 articles besides several short notices which appear in the Proceedings, 23 plates, and 629 pages of letter-press.

The following is a comparison of the sections of the work, with last year's volume:—

	1878.	1877.
Miscellaneous	190 pages	316 pages.
Zoology	154 ,,	173 ,,
Botany	78 ,,	61 ,,
Chemistry	36 ,,	7 ,,
Geology	48 ,,	42 ,,
Proceedings	63 ,,	62 ,,
Appendix	60 ,,	63 ,,
	629 ,,	724 ,,

The number of Volumes of Transactions now on hand, is as follows:—

Volume I., 2nd edition, 448; Volume II., none; Volume III., 10; Volume IV., 8; Volume V., 74; Volume VI., 80; Volume VII., 169; Volume VIII., 36; Volume IX., 177; Volume X., 30.

The appended statement of accounts shows a balance to the credit of the Board of £37 1s. 10d.

The annual reports of the various departments attached to the Institute, are also appended, together with a list of the additions to the Library.

James Hector, Manager.

Approved by the Board, 4th September, 1878.

W. B. D. Mantell, Chairman.

Museum.

The number of names entered in the Visitors' book at the Museum during the past year has been 15,000.

Since the 7th July the Museum has been opened to the public for two hours on Sunday afternoons, and the large attendance, varying from 300 to 800 persons, indicates that there are many who are glad to take advantage of the opportunity thus afforded for examining the collections.

There have been 9,880 specimens added to the collections during the past year; 7,519 of which are mineral and fossil specimens obtained during the geological survey of the colony which is in progress, and 135 specimens deposited on loan.

Herbarium.—The collections in this department have received only inconsiderable additions, and the arrangements for the thorough preservation of the dried plants are quite insufficient. It has, therefore, been considered inadvisable to unpack the large herbarium of foreign plants until

proper cabinets have been provided for their reception, so that this special gift from the Trustees of the British Museum, which numbers 28,000 species of plants for reference, is still inaccessible to students.

Natural History Collections.—The detailed study and classification of the collection is rapidly advancing, and arrangements have been made with the Education Department to secure the services of a wood engraver, so that the illustrations for the new editions of the Natural History Catalogues, which are now out of print, may be obtained in a form that will admit of their being also used for the illustration of elementary text-books for the use of schools.

Mammalia.—The classification of the New Zealand Cetacea has undergone revision, and the results, so far as they relate to the larger forms, have been published in the Transactions of the Institute ("On the Whales of the New Zealand Seas," by Dr. Hector. Vol. X., p. 331).

The most important addition to the collection of this section has been a fine skeleton of the Whale-killer (*Orca pacifica*), presented by the Royal Society of Tasmania.

Birds.—The principal additions to the collection of birds during the year, was obtained by exchange from the private Museum of Mr. Macleay, F.L.S., at Sydney.

Fishes.—Very extensive additions have been made to the alcoholic collections in this department, 360 specimens having been received, including a typical collection of the Australian sea and river fishes; a small collection of Polynesian fish made by Lord Hervey Phipps; and a series of the fishes of the Atlantic Coast of the United States, contributed by the Smithsonian Institute.

The collection of New Zealand fishes has been greatly extended and improved by the substitution of fresh preparations.

Invertebrata.—The additions in this section number 887, and consist chiefly of Australian Crustacea, Echinodermata, and Mollusca, and a large series of preparations of the New Zealand Mollusca to facilitate the study of the soft parts of the animals.

Mention has also to be made of a valuable collection of New Zealand Insects, 37 in number, collected and presented by the Rev. Father Sauzeau, of Blenheim.

Ethnological.—The only important addition has been a collection of the weapons of the Isle of Paris (New Caledonia) natives, the most interesting of which are sling-stones made of steatite, which are projected from a sling made of cloth spun from the hair of the flying fox.

Minerals.—In addition to the various mineral and rock specimens obtained by the Geological Survey, a very valuable series, numbering 400

specimens, illustrating the geology of Canada, from Mr. A. R. C. Selwyn, F.R.S., the Director of the Geological Survey of the Province, have been added, and a few ores of interest, collected in Cornwall, have been received from Mr. J. D. Enys, F.G.S.

The collection of New Zealand minerals and ores has been re-arranged and catalogued, and the volcanic and metamorphic rocks are now undergoing a more thorough chemical and microscopical examination than they have hitherto received, while, at the same time, duplicate specimens are being selected for exchange.

Palæontology.—The most important collection of foreign fossils added to the Museum during the past year, is a series illustrating the carboniferous rocks of New South Wales and Tasmania, obtained by the Director during a visit to Australia. This series has proved of great service in comparing the equivalent formations in New Zealand.

Geological Survey Collections.—These have been very ample and important in their bearing on the geology of the Islands, and especially in relation to the Lower Mesozoic rocks, which have, until now, been very imperfectly understood.

The chief field-work of the year was the detailed survey of the Hokanui range in Southland, which has, for many years, been known to present the most typical development of the formations from Jurassic to Permian.

The results obtained are fully detailed in the Geological Reports for the year, but it may be stated here, that the above formations form a stratigraphical sequence, but were divided into 76 well-defined beds, the outcrops of which were traced and studied in section, over an area of 32 square miles.

The fossils, which number over 5,000 specimens, were collected from twenty-five distinct horizons, and form a very large and important addition to the palæontological data now in the Museum, which are only partially arranged and worked out :—

The total thickness of the strata represented in the sections is 21,000 feet, viz. :—

Upper Oolite	3,500
Middle Oolite	850
Lower Oolite	2,200
Lias and Rhætic	2,000
Permian Triassic	6,400
Permian Carboniferous...	6,150

The most remarkable feature is the great development of our Infra-Triassic Marine formation, characterized by a great profusion of Brachiopoda, several of these forms being generically distinct from any hitherto described, while there is a total absence of any true Spirifera. It is thus

rendered probable that we have in the New Zealand area, developments of Lower Mesozoic strata, representing gaps in the record elsewhere.

A further examination of the Mount Potts *Spirifer* beds, during the past year, has afforded a large number of fossils and proved the existence of three marked horizons in that locality,—the Upper Plant beds; the *Spirifer* beds (although no true *Spirifer* is present) corresponding to the Lower Triassic of the Hokanui section; and at the base, beds containing *Glossopteris*, which is a characteristic fossil of the New South Wales Coal Fields.

A thickness of 2,000 feet separates the *Glossopteris* from the *Spirifer* beds. From the bone beds associated with the latter, a good series of the Saurian bones was also collected, some of the vertebral centra having enormous proportions, being 18 inches in diameter, and 3½ inches in length. Besides vertebræ, rib and limb bones were also obtained, and what appear to have been dermal plates; but the large blocks in which these interesting remains are embedded are not yet worked out sufficiently.

A further discovery of great interest, is the determination by Mr. McKay of the age of the Maitai calcareous slates near Nelson. These underlie unconformably the whole of the beds that are developed in the Hokanui section, and contain the true *Spirifer bisulcatus* and *Productus punctatus* of the Middle Coal-measures of New South Wales.

The discovery of Graptolites in the strata of the Collingwood district during the past year, is also an important advance in New Zealand palæontology.

In Upper Mesozoic formations, the most interesting novelty is the discovery by Mr. Cox of an extension of the West Coast Coal-measures towards the limit of Te Anau lake, while the heavy bedded grits and conglomerates enter into the structure of lofty mountain ranges.

The additions to the tertiary fossils have chiefly been from the East Coast of Wellington, while the evidence of the relative position of the Greensands and Chalk marls to the Miocene strata of the Taipos and the Pliocene Tertiaries of the Wairarapa, have received support by ample collections.

The New Zealand Fossils now accumulated in the course of the Geological Survey, represent collections from 450 different localities, and comprise about 6,200 trays, which have been thoroughly classified, and 1,200 specific types withdrawn into a separate collection for publication. A large number of types have been figured and their publication will be proceeded with as rapidly as the other work of the Department will permit.

Publications.—The volume of Geological Reports for the past year, is now in the press and will contain the progress reports of the Survey, and in addition descriptions and figures of the most important of the Lower Mesozoic fossils.

Meteorology.

The number of Meteorological Stations is now 14, namely:—Mongonui, Auckland, Taranaki, Napier, Wanganui, Wellington, Nelson, Cape Campbell, Christchurch, Bealey, Hokitika, Dunedin, Queenstown, Southland.

The returns made by the Observers are published in the usual form, but it is very desirable that the re-organization of this branch should be effected, with the view of reducing the present number of stations, and substituting a few thoroughly equipped observatories, and a large number of stations where only rainfall, direction of wind, and temperature would be observed. By this means the same expenditure would give more valuable results.

Time-ball Observatory.

The necessity for certain additions and repairs to the Observatory have been represented to Government, and, in particular, the desirability of having a second rating clock, as at present, when the single astronomical clock is under adjustment, intervals occur during which the time-ball cannot be dropped with accuracy.

Laboratory.

The following is a summary of analyses performed in the Colonial Laboratory during the past year:—

1. Coals	15
2. Rocks and Minerals	46
3. Metals and Ores	53
4. Examination for Gold and Silver	70
5. Waters	22
6. Miscellaneous	25
Total	231

A full account of these analyses will be found in the Annual Report on the work performed in the Laboratory, published separately.

Accounts of New Zealand Institute, 1877–8.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
Balance in hand, 23rd August, 1877	123	9	4	Expenses of Printing Proceedings of Vol. IX., of Index, and Binding	91	16	11
Vote for 1877-8	500	0	0	Expenses of Printing Vol. X.	510	8	6
Contribution from Wellington Philosophical Society ..	31	10	0	Miscellaneous Items	21	18	1
Sale of Volumes	6	6	0	Balance	37	1	10
	£661	5	4		£661	5	4

Arthur Stock,
Hon. Treasurer.

September 4th, 1878.

APPENDIX.

THE CLIMATE OF NEW ZEALAND.

METEOROLOGICAL STATISTICS.

The following Tables, etc., are published in anticipation of the Report of the Inspector of Meteorological Stations for 1878.

TABLE I.—TEMPERATURE of the AIR, in shade, recorded at the Chief Towns in the NORTH and SOUTH ISLANDS of NEW ZEALAND, for the year 1878.

PLACE.	Mean Annual Temp.	Mean Temp. for (SPRING) Sept., Oct., Nov.	Mean Temp. for (SUMMER) Dec., Jan., Feb.	Mean Temp. for (AUTUMN) Mar., Apl., May.	Mean Temp. for (WINTER) June, July, Aug.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.
NORTH ISLAND.	Degs.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Mongonui ..	61·5	61·0	68·1	62·3	54·7	17·8	53·0
Auckland ..	58·8	57·9	65·2	60·7	51·6	13·8	46·8
Taranaki.. ..	56·5	55·7	62·5	57·9	50·0	15·4	50·0
Napier	59·7	61·0	65·9	60·6	51·4	15·1	54·0
Wanganui ..	55·5	55·8	62·4	55·4	48·3	20·4	61·0
Wellington ..	55·1	54·7	60·9	56·9	47·8	13·0	48·2
Means, etc., for North Island	57·8	57·6	64·1	58·9	50·6	15·9	61·0
SOUTH ISLAND.							
Nelson	54·2	55·8	60·8	54·7	45·7	21·9	52·0
Cape Campbell ..	56·3	56·4	61·5	57·8	49·3	10·4	41·8
Christchurch ..	52·8	54·8	59·6	53·6	43·2	19·4	66·5
Hokitika	51·6	51·6	57·9	52·9	44·2	11·9	43·2
Dunedin	49·9	51·9	54·4	51·0	41·9	14·4	60·0
Queenstown ..	*50·1	50·2	57·7	55·2	39·0	16·7	62·4
Southland ..	48·9	51·0	54·5	49·6	40·6	17·3	60·0
Means, etc., for South Island	51·9	53·1	58·0	53·5	43·4	16·0	66·5
Means, etc., for North and South Islands	54·8	55·3	61·0	56·2	47·0	15·9	66·5

* For 11 months only.

TABLE II.—Barometrical Observations.—Rainfall, etc., recorded for the year 1878.

Place.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
North Island.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10.
Mongonui ..	29·961	1·317	·419	76	40·140	6·0
Auckland ..	29·995	1·291	·389	78	37·160	6·4
Taranaki ..	29·952	1·430	·386	79	56·730	6·9
Napier	29·890	1·587	·354	69	21·100	2·6
Wanganui ..	30·002	1·500	·310	69	40·920	5·3
Wellington ..	29·873	1·775	·351	80	54·602	5·4
Means for North Island	29·945	1·483	·368	75	41·775	5·4
South Island.						
Nelson	29·826	1·357	·316	74	51·900	5·1
Cape Campbell ..	29·964	1·630	·344	75	16·480	5·7
Christchurch ..	29·804	1·919	·280	69	13·540	5·7
Hokitika ..	29·876	1·382	·337	86	154·446	7·1
Dunedin ..	29·680	1·685	·262	72	45·235	6·0
Queenstown ..	29·713	1·760	·243	66	60·020	6·1
Southland ..	29·726	1·960	·293	83	54·020	7·0
Means for South Island	29·798	1·670	·296	75	56·520	6·1
Means for North & South Islands	29·871	1·576	·332	75	49·147	5·7

TABLE III.—Wind for 1878.—Force and Direction.

Place.	Average Daily Velocity in Miles.	Number of Days it blew from each point.								
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm*.
North Island.										
Mongonui ..	153	22	35	28	17	32	89	56	63	23
Auckland ..	299	29	34	18	12	34	113	84	41	0
Taranaki ..	239	47	28	18	50	6	130	47	39	0
Napier ..	237	20	77	14	13	56	63	60	53	9
Wanganui ..	263	3	8	0	27	1	53	70	147	56
Wellington ..	243	1	40	2	84	1	6	5	224	2
South Island.										
Nelson ..	170	60	65	8	37	9	122	3	61	0
Cape Campbell	479	8	2	1	47	46	8	52	167	34
Christchurch	167	3	117	33	6	4	138	18	46	0
Bealey ..	232	103	23	9	23	15	26	26	90	50
Hokitika ..	—	17	32	67	7	7	145	41	49	0
Dunedin ..	170	8	65	15	6	13	113	28	8	109
Queenstown ..	—	5	15	2	8	3	59	39	156	78
Southland ..	244	23	41	23	19	6	90	123	40	0

* These returns refer to the particular time of observation, and not to the whole twenty-four hours, and only show that no direction was recorded for the wind on that number of days.

TABLE IV.—Bealey (Interior of Canterbury), at 2,104 feet above the sea. 1878.

Mean Annual Temp.	Mean Daily Range of Temp. for year.	Extreme Range of Temp. for year.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
Degs. 45·7	Degs. 13·8	Degs. 78·0	Inches. 29·621*	Inches. 1·849	Inches. ·203	Sat.=100. 64	Inches. 155·891	0—10. 5·9

* Reduced to sea level.

TABLE V.—Earthquakes reported in New Zealand during 1878.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Taranaki	..	..	..	..	..	..	..	8	..	..	..	..	1
Napier	..	..	..	..	..	5* 23	..	..	..	..	..	..	2
Wanganui	..	..	..	4	..	23*	20* 21	8*	..	21	..	..	6
Foxton..	..	..	..	..	..	..	5*	..	..	..	..	..	1
Greytown	..	..	..	..	..	..	5*	..	..	..	..	..	1
Wellington ..	..	..	..	28	..	23	5 20	8	14	21*	..	6, 7 12	10
Cape Campbell ..	..	..	..	11*	..	3*	..	..	14*	21* 27	..	..	5
Blenheim	..	..	..	11*	..	..	..	..	..	..	..	..	1
Kaikoura	..	..	..	..	..	..	..	..	14*	..	..	..	1
Nelson	..	..	..	..	..	24	..	..	14*	21*	..	..	3
Westport	..	..	..	..	..	..	..	..	14*	..	..	..	1
Hokitika	..	..	11*	..	..	..	29	..	..	21	..	..	3
Lyttelton	..	..	..	..	..	..	..	..	14*	..	..	..	1
Christchurch	..	..	..	..	..	..	..	..	14	21	..	..	2
Rangiora	..	..	..	..	..	..	..	..	30	..	..	..	1
Lawrence	..	..	..	..	..	..	..	24*	..	..	..	..	1
Arrow	..	..	..	..	..	..	..	24*	..	..	..	..	1
Queenstown ..	15	12	..	25*	..	..	..	23 24*	..	21	8 14* 27	..	9
Wallace-town ..	..	..	..	..	..	..	..	25*	..	..	..	..	1

The figures denote the days of the month on which one or more shocks were felt. Those with an asterisk affixed were described as *smart*; those with a dagger as *severe shocks*. The remainder were only slight tremours, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. This table is therefore not reliable so far as indicating the geographical distribution of the shocks.

TABLE VI.—COMPARATIVE ABSTRACT for 1878 and previous Years.

STATIONS.	BAROMETER.		TEMPERATURE from Self-registering Instruments, read in Morning for 24 hours previously.					COMPUTED FROM OBSERVATIONS.		RAIN.		WIND.		CLOUD.
	Mean reading.	Extreme Range.	Mean Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass	Mean Elastic Force of Vapour.	Mean Degree of Moisture. (Saturation=100).	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and Date.	Mean Amount (0 to 10).
NORTH ISLAND.														
Mongonui ..	29·961	1·317	61·5	17·8	53·0	—	—	·419	76	40·140	163	153	631—7 Jan.	6·0
Previous 12 yrs	29·949	—	60·6	—	—	—	—	§·424	§76	54·698	166	—	—	—
Auckland ..	29·995	1·291	58·8	13·8	46·8	151·4	26·3	·389	78	37·160	212	299	703—22 Aug.	6·4
Previous 14 yrs	29·944	—	59·5	—	—	—	—	·409	79	44·345	188	—	—	—
Taranaki ..	29·952	1·430	56·5	15·4	50·0	150·0	—	·368	79	56·730	196	239	660—12 Oct.	6·9
Previous 14 yrs	29·940	—	57·3	—	—	—	—	**·371	**74	56·462	161	—	—	—
Napier	29·890	1·587	59·7	15·1	54·0	142·0	28 0	·354	69	21 100	98	237	550—22 Nov.	2·6
Previous 10 yrs	29·938	—	58·3	—	—	—	—	·384	74	36·195	108	—	—	—
Wanganui ..	30·002	1·500	55·5	20·4	61·0	146·0	23·0	·310	69	40·920	173	263	698—31 July	5·3
Previous 6 yrs	30·039	—	55·7	—	—	—	—	·329	72	41·059	135	—	—	—
Wellington ..	29·873	1·775	55·1	13·0	48·2	146·0	28·0	·351	80	54·602	178	243	800—14 May	5·4
Previous 14 yrs	29·905	—	54·8	—	—	—	—	·332	72	51·666	157	—	—	—
SOUTH ISLAND.														
Nelson	29·826	1·357	54·2	21·9	52·0	140·0	—	·316	74	51·900	101	170	426—16 May	5·1
Previous 14 yrs	29·893	—	55·5	—	—	—	—	·361	74	62·575	88	—	—	—
Cape Campbell ..	29·964	1·630	56·3	10·4	41·8	—	—	·344	75	16·480	60	479	1,297—19 May	5·7
Previous 4 yrs	29·990	—	57·9	—	—	—	—	·367	75	19·667	93	—	—	—
Christchurch ..	29·804	1·919	52·8	19·4	66·5	159·2	11·3	·280	69	13·540	104	167	554—16 Nov.	5·7
Previous 14 yrs	29·884	—	53·3	—	—	—	—	·324	76	25·719	118	—	—	—
Bealey	29·621	1·849	45·7	13·8	78·0	—	—9·0	·203	64	155·891	207	¶232	665—11 Jan.	5·9
Previous 10 yrs	29·836	—	46·4	—	—	—	—	·253	77	98·554	171	—	—	—
Hokitika ..	29·876	1·382	51·6	11·9	43·2	147·0	24·0	·337	86	154·446	259	—	—	7·1
Previous 12 yrs	29·930	—	52·6	—	—	—	—	·345	85	116·097	188	—	—	—
Dunedin ..	29·680	1·685	49·9	14·4	60·0	142·0	21·0	·262	72	45·235	157	170	660—16 May	6·0
Previous 14 yrs	29·825	—	50·5	—	—	—	—	·280	74	34·092	160	—	—	—
Queenstown ..	29·713	1·760	50·1	16·7	62·4	—	—	·243	66	60·020	156	—	—	6·1
Previous 6 yrs	*29·840	—	50·4	—	—	—	—	·244	66	31·607	120	—	—	—
Southland ..	29·726	1·960	48·9	17·3	60·0	158·0	—	·293	83	54·020	232	244	613—22 Nov.	7·0
Previous 13 yrs	29·805	—	†49·9	—	—	—	—	‖·274	‖75	44·967	174	—	—	—

* Previous 5 years. † Previous 9 years. § Previous 11 years. ** Previous 13 years. ‖ Previous 8 years. ¶ 10 months only.

NOTES ON THE WEATHER DURING 1878.

January.—The weather throughout for this month has been unusually cold, wet, and boisterous for the time of year; frequent S.W. gales of violence have occurred, accompanied with thunder and hail, and the temperature has been considerably lower than the average, generally 4° and 5° below; altogether it was a very unseasonable month. Earthquake at Queenstown on 15th, at 8·45 p.m., slight.

February.—Fine weather generally throughout, with small rainfall at most places; strong winds were experienced at some of the stations, but no very violent gales; high barometer readings prevailed, but temperature below the average. Earthquake reported by Observer at Queenstown on 12th, at 3 a.m., slight.

March.—Except at the Southern stations, the rainfall was much below the average, and fine weather experienced; in the South, however, it was at times severe, and excessively wet and stormy. An earthquake was reported at Hokitika on 11th, at 9·35 p.m., slight.

April.—The weather was exceedingly fine during this period, except at Bealey, where the rain was in excess, with strong westerly winds; also at Hokitika very wet, but winds moderate; and in the extreme South the rain was over the average, with cold stormy westerly weather. Earthquakes occurred at Wanganui on the 4th, at 12·50 a.m.; at Wellington on 28th, at 6·25 p.m., lasting six seconds, N. and S., very slight; at Cape Campbell on 11th, at 9 a.m., smart, and Blenheim 11th, at 8·55 a.m., sharp, N. to E.; at Queenstown on the 25th, at 3·30 a.m., smart. A meteor was observed at Christchurch on 27th, in S.E.

May.—On the whole, rain rather below the average; the temperature was lower than usual for time of year; very cold stormy weather experienced at most of the stations, with snow, and a good deal of thunder. A meteor seen in South on 7th, very brilliant.

June.—A very cold, wet, and severe month throughout. The rainfall at nearly all places in excess, and frequent thunder storms, with hail and snow, and prevailing S.W. winds; very low atmospheric pressure throughout. Earthquakes at Napier on 5th, at 11·15 p.m., sharp, and on 23rd at 3·15 p.m., not so marked; at Wellington on 23rd, at 7·38 am., slight, direction S.E.; at Wanganui on 23rd, at 4·50 a.m., strong shake; at Nelson on 24th, at 8·30 a.m.; at Cape Campbell on 3rd, at 12·15 a.m., smart.

July.—Tolerably fine weather for time of year, though heavy rain at some of the stations, with strong gales, chiefly from westward; very heavy snow-storms, with hail and severe frosts, occurred in the South. Earthquakes occurred on 5th at Wellington, at 10·18 p.m., slight; at Foxton, 10·20 p.m., sharp, with loud noise; at Greytown, 10.17 p.m., smart, with noise; on 20th, at Wellington, 11·39 p.m., very slight; and at Wanganui, at midnight, smart, and on 21st a lighter shock at 3 a.m.; at Hokitika, 29th, at 12 a.m., slight.

August.—The weather was generally wet and stormy, principally from S.W.; frequent gales occurred, also snow and hail storms; low atmospheric pressure prevailed, and temperature below the average for same month in previous years. Earthquakes—Taranaki, 8th, at 8 a.m.; at Wellington, on 8th, at 7·53 a.m., slight double shock; Wanga-

nui, on 8th, at 8·10 am., heavy; at Lawrence and Arrow, on 24th, rather severe; at Queenstown, on 23rd, at 7·35 p.m., slight, and a heavy shock on 24th, at 2·38 p.m.; at Southland, a sharp shock on 25th, at 2·40 p.m.

September.—Very high barometer readings throughout, and high temperature; in the North rain rather below the average, but in the South in excess, which, combined with the flooding of the snow rivers, owing to the hot N.W. winds and warm rain, caused considerable damage to several districts in the South. Earthquakes—On the 14th, at Wellington, 5 a.m., slight; Kaikoura, 4·45 a.m., smart; Nelson, same time, smart; Westport, 4·40 a.m., smart; Lyttelton, at 4·50 a.m., also smart; Cape Campbell, at 4·30 a.m., smart; Christchurch, at 4·30 a.m., S. to N.; also on the 30th, felt at Rangiora, from E. to W.

October.—Wet, stormy S.W. and N.W. weather generally prevailed throughout this month. Earthquakes—Wellington, on 21st, at 10·55 p.m., sharp, followed by lighter shocks; at Wanganui, on 21st, at 11 p.m., slight rumble; at Nelson, on 21st, sharp shock, at 10·55 p.m., also at 11·45 p.m. another movement; Cape Campbell, on 21st, at 11·15 p.m., sharp, and on 27th, at 3·30 a.m., slight; Christchurch, on 21st, at 11 p.m.; Hokitika, on 21st, at 11 p.m., slight; Queenstown, at midnight, slight. Meteors observed at Mongonui on 31st, and at Christchurch on 30th.

November.—Rather a wet stormy month, wind generally from S.W. and westerly; temperature on the whole about the average; frequent thunder storms occurred. Earthquakes reported at Queenstown on 8th, at 3·20 a.m.; on 14th, at 12·8 p.m., smart; and on 27th, at 6·40 a.m.

December.—Generally fine, dry, warm weather at Northern stations, but in the South excessive rain and frequently stormy cold weather experienced for time of year. Earthquakes felt at Wellington on 6th, at 9 p.m., slight; on 7th, at 5 a.m., slight; on 12th, at 11·39 a.m., slight, followed by a smarter shock. Meteors observed in North on 15th, and in South on 20th and 25th.

NOTE.—It is intended that a complete record of the titles of scientific papers published during each year, which have reference to New Zealand, shall be issued with future volumes of Transactions. The following list for the past year, which has been kindly compiled by Professor Hutton, will be of some use to students in the section of Natural History.

RECORD OF PAPERS ON NEW ZEALAND NATURAL HISTORY, 1878–9.

Macleayius australiensis compared with *Balæna biscayensis.* M. F. Gasco. Ann. Nat. Hist., Series 5, Vol. 2, p. 495.

On the Genus *Mesoplodon.* W. H. Flower. Trans. Zool. Soc. of London, X., p. 415.

Cyanoramphus novæ-zealandiæ distinct from *C. saisseti.* E. Layard. Ibis, 1879, p. 110.

Anas gibberifrons probably identical with *A. castanea.* E. P. Ramsay. P.L.S. of N.S.W. III., p. 38.

On the *Larinæ.* Howard Saunders. P.Z.S. of London, 1878, p. 155.

Number of cervical Vertebræ in *Dinornis.* F. W. Hutton. Ann. Nat. Hist. 5, 1, 407, and 5, 2, 499.

Two new Fishes from New Zealand. F. W. Hutton. Ann. Nat. Hist., 5, 3, 53.

The *Dascillidæ* of New Zealand. D. Sharp. Ann. Nat. Hist. 5, 2, 40.

Additions to the Geodephagous Fauna of New Zealand. H. W. Bates. Ent. Month. Mag., XIV., p. 191; and XV., pp. 22, 57.

New Species of *Coleoptera* from New Zealand. D. Sharp. Ent. Month. Mag., XIV., pp. 7, 39; and XV., pp. 47, 81.

List of the *Hemiptera* of New Zealand. F. Buchanan White. Ent. Month. Mag., XIV., p. 274; and XV., pp. 31, 73, 130, 159, 213.

New *Crustacea* from New Zealand. T. W. Kirk. Ann. Nat. Hist., 5, 2, 465.

Notes on the Structure of *Peripatus novæ-zealandiæ.* F. W. Hutton. Ann. N.H., 5, 1, 204.

On *Spirula australis.* R. Owen. Ann. Nat. Hist., 5, 3, 1.

On some Fresh-water Shells from New Zealand. Rev. J. Tenison-Woods. P.L.S. of N.S.W., III., p. 135.

The Genus *Lymnœus* in Australia. A. Brown. Ann. Nat. Hist., 5, 2, 493.

New Species of Opisthobranch *Mollusca* from New Zealand. T. F. Cheeseman. P.Z.S. of London, 1878, p. 275.

Revision des Coquilles de la Nouvelle-Zélande. F. W. Hutton. Journal de Conchyliologie 1878, p. 1.

Pentagonaster dilatatus and *Asterina novæ-zealandiæ*, Perrier. New Species from New Zealand. Arct. Zool. Exper., V., pp. 33 and 228.

Nematoid Worm from Campbell Island. J. Chatin. Ann. Nat. Hist., 5, 2, 40.

New Hydroids from Australia and New Zealand. D'Arcy W. Thompson. Ann. Nat. Hist., 5, 3, 95.

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